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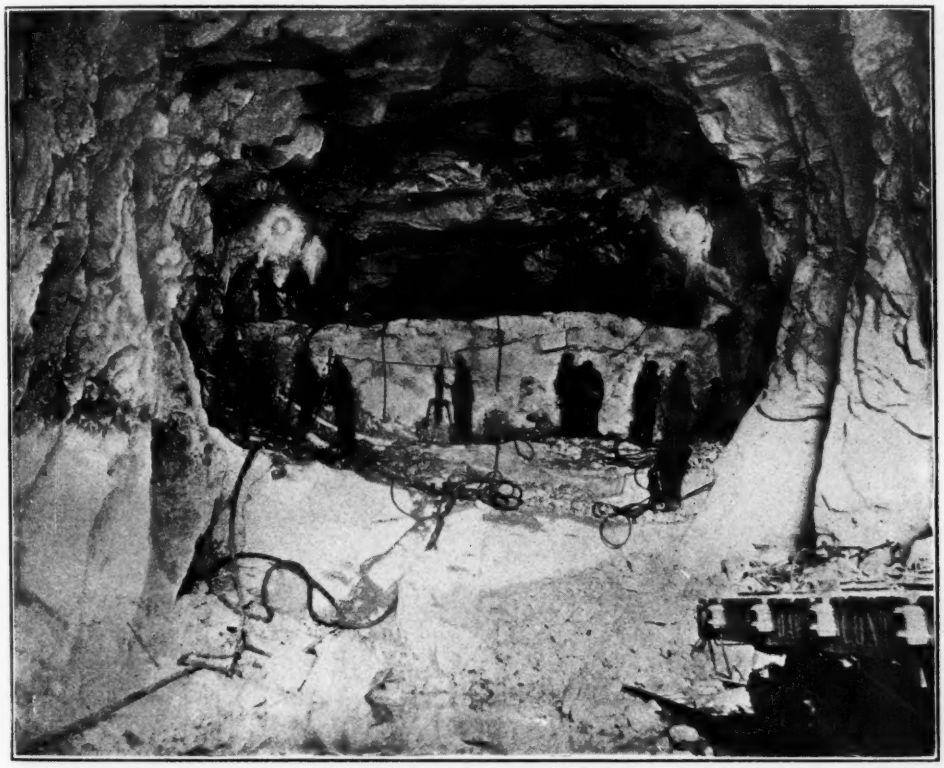


FIG. I. HEADING AND BENCHES. YADKIN RIVER TUNNEL.

AN UNUSUAL DEVICE IN DAM CONSTRUCTION

BY FRANK RICHARDS.

A scheme of water power development of unusual interest, it being one of considerable magnitude with some features of novelty, is now in process of execution on the Yadkin River, near Whitney, N. C., for the Southern Aluminum Company. It is computed that 120,000 horse power will be developed.

The entire construction is undertaken by a single contractor, the Hardaway Contracting Company, Inc., and the work comprises the building of a dam 227 feet high, from the lowest point of the river bed. and 1300 feet long,

a power house 60 feet by 600 feet and the preparation of the factory site for the Aluminum Company. The work will require 650,000 cubic yards of excavation and about 450,000 cubic yards of masonry.

In connection with the construction of the dam a novel arrangement has been adopted for the diversion of the flow of the river until the work is completed. Near the eastern end of the dam two shafts or wells are sunk, 60 feet in diameter at the top and 40 feet at the bottom, these connecting with two horizontal tunnels, each 40 feet wide and 34 feet high, which pass through the mountain that forms the east bank of the river. Through the wells and tunnels the entire flow of the river can be discharged during the construction of the dam. The wells will be closed by gates when the pond is to be filled and the water power utilized. In case of unusual floods in the river these gates can all be opened and a large portion of the surplus water can be carried off in this way.

Although the job is necessarily of a temporary character, the contractor's operating plant, the largest on record in the South, is intended to embody all the up to date conveniences and economies. From 6000 to 8000 horse power is required, and a standard transmission line, with steel towers and two independent copper lines, has been built from the line of the Southern Power Company at Albemarle, a distance of about seven miles.

The air compressing plant comprises four Ingersoll-Rand, Class PE, direct connected, electrically driven two-stage machines, with an aggregate output of 11,000 cu. ft. of free air per minute, delivered at 100 lb. gage pressure. In connection with the large and efficient intercoolers on these machines separators are provided to remove all the liberated water from the air before it enters the high pressure cylinder. While these compressors run at constant speed, automatic clearance controllers regulate the output according to the demand, without any sacrifice of power for work not done. Fig. 2 shows the air cylinder ends of these machines.

Following naturally in the list of equipment come 40 Leyner-Ingersoll rock drills with their mountings and appurtenances. There are 7 steam shovels, 17 forty ton American locomotives, 20 twelve yard Western Wheeled Scraper Company steel side dump cars, 10 standard steel, 100,000 lb. capacity, flat cars, 30 twenty ton American Hoist and Derrick Company steel guy derricks, with 115 feet mast and 100 ft. boom, operated by 40 H. P. Lidgerwood engines.

Every effort has been made to have the plant for crushing stone, and mixing concrete as complete and efficient as possible. There is one No. 21 Gyratory crusher, with six No. 6 crushers of the same type, four 54 in. sand screens and four 2 yard mixers, with the necessary elevators and screens. The mixers were furnished by the Municipal Engineering & Contracting Company of Chicago, and all the crushers, screens, elevators, and electric motors for running the plant were furnished by the Allis Chalmers Manufacturing Company, Milwaukee.

Incidentally it may be mentioned that the wheel machinery for the Aluminum Company's power house is to be furnished by S. Morgan Smith Company, York, Pa. The electric machinery will be furnished by the General Electric Company and the flume work by the Holyoke Steam Boiler Works, Holyoke, Mass.

As one of the first requirements in the arrangement of operations, the two tunnels spoken of are nearly completed, and the admirable photo, Fig. 1, taken at a favorable stage of the work, tells so clearly the story of the method followed as to make detailed explanation superfluous. As the tunnel section was much larger than that of any double track railroad tunnel there was ample room to work, and the rock was so solid that no timbering was required.

First a heading was driven of sufficient height for comfortable working, and this was followed by two benches, the drills being mounted upon columns for the first operation, while tripods were used for the remainder of the work. In the picture the principal actual work noticeable is the drilling on the lower bench. The end of a standard platform car is seen at the lower righthand corner, and the projecting portion of the rail upon which the car stands indicates the bottom of the tunnel.

The work requires much more rock cutting, besides that in the shafts and tunnels, and there may be opportunity for another interesting story later. The complete elimination of the water trouble at the beginning was an immense advantage.

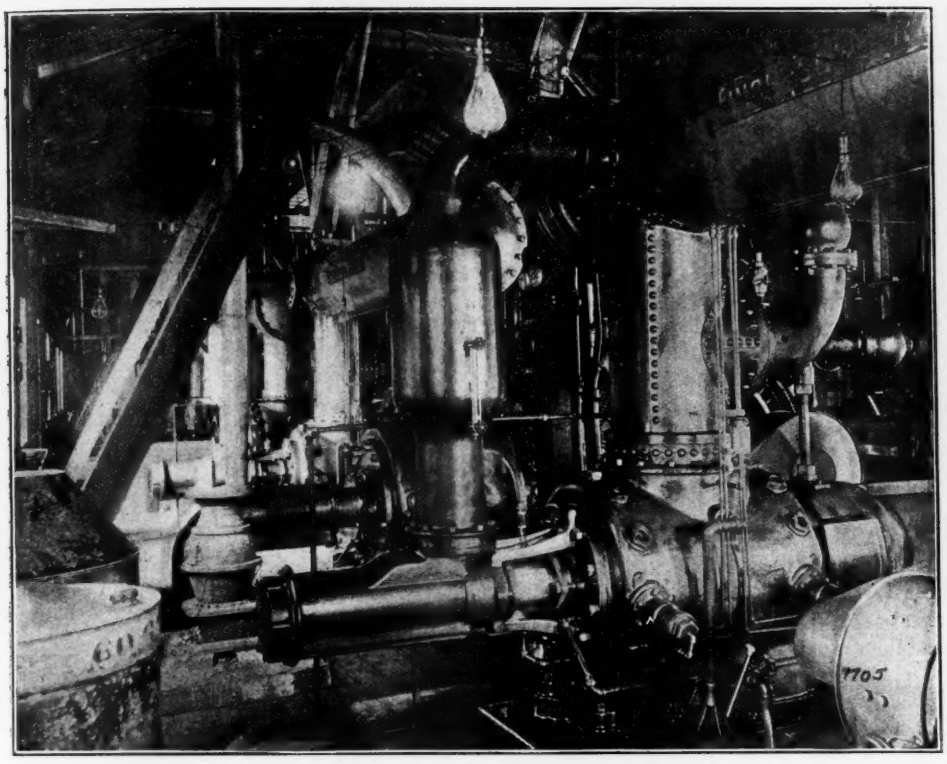


FIG. 2. COMPRESSORS FOR YADKIN RIVER DAM.

All the information here given is supplied directly by Mr. B. H. Hardaway, President of the Hardaway Contracting Company, Incorporated, Whitney, North Carolina.

HIGH PRESSURES

Investigations with very high pressures have lately been made by Dr. Bridgeman of the physical laboratory at Harvard University, and he has probably been experimenting with higher pressures than have ever before been reached. In some of his experiments he obtained a pressure of something like 300,000 pounds per square inch, and succeeded in measuring the pressure with reasonable accuracy up to 175,000 pounds per square inch. What these pressures mean will be understood when we consider that the highest pressures commonly produced are those exerted by the explosions in modern arms with smokeless powder, where a pressure up to 30,000 pounds or more per square inch is developed when the gun is fired. Pressures of 200,000 pounds per square inch have been produced by exploding nitro-glycerine in a closed vessel.

THE PORTLAND CANAL TUNNEL

BY LLOYD C. WHITE.*

The driving of the Portland Canal tunnel was not an important operation either as to costs established or rate of progress; but, on account of its being the largest undertaking of its kind in the district, the methods and costs may be of interest. The work was carried on by the Portland Canal Tunnels, Ltd., a company with head offices at Victoria, British Columbia. The power-plant of the Portland Canal Mining Co. was leased for the work, and this expense is not included in the following costs. Also the underground equipment is entirely written off.

PURPOSE OF THE TUNNEL.

The portal of the tunnel is situated about 3½ miles north of Stewart, British Columbia, and is 300 ft. above sea-level. The objects of the tunnel are to provide a working entry to the mines located in the Portland Canal fissure zone, and to provide a means of further

*Mining and Scientific Press, San Francisco

exploring veins in this zone; also to develop water power.

The heading, 7½ by 8 ft. in the clear, was driven a distance of 2916 ft. at an average rate of 8 ft. per day. The best weekly record was 67 ft., and the best monthly 271 ft. Two 8-hr. shifts per day were employed, consisting of four machine-men and three shovelers. After the 1000-ft. mark was passed, four shovelers were employed. Compressed air at 100 lb. pressure was supplied by a water-driven, 520-cu. ft., Rand class D-2 compressor, and delivered into the tunnel through a 4-in. pipe. Two 3¼-in. Ingersoll-Rand E-44 drills, mounted on a 7-ft. single screw bar were used. Miners and shovelers started work together. The bar was set up above the rock pile, and from 10 to 12 holes were drilled from this position. By this time the rock was out, the bar was lowered, and three lifters were drilled. The first 1600 ft. of the tunnel is in greenstones, while the remainder is in argillites, quartz and porphyry. With but two exceptions during the entire work, a round was drilled every shift. Five-foot rounds were drilled, but seldom "bottomed."

Three 20-cu. ft. cars were used, and tramming was done by the shovelers. The track, of 20-lb. rails, 18-in. gage, and ½% grade, was laid on the left-hand side of the tunnel. One switch, about half way in, was used; the empty incoming car was taken off the track near the face to allow the loaded one to pass. At a point 730 ft. from the portal an 80-ft. adit was run, opening into a canon. This not only made an excellent dumping place, but shortened the tramming distance by 750 ft The shovelers laid and leveled the track. The floor from within 3 ft. of the face to 40 ft. back was covered with steel plates before blasting. A drain 12 in. deep was made on the right side of the tunnel, the lifter being drilled low for this purpose.

Ventilation was provided by two Schutte & Koerting blowers. The ventilating line consisted of 10-in. diameter, 24-gage, galvanized pipe. The pipe was made in 10-ft. lengths, with riveted joints, painted with tar, and wrapped with muslin. The compressor was run two hours after blasting to clear the tunnel. After the 2000-ft. mark was reached, more or less trouble was experienced with the ventilation, especially in rainy weather. Except in a few places the tunnel was dry, and after the first 140 ft. required no timbering. The writer, who had charge of the work, was the only boss. The tunnel is still being driven, but only as a 5-ft. drift and secondary to exploration on veins found in the tunnel.

All supplies were bought at Vancouver, British Columbia, and came north by steamship. The prices of some of the more important supplies at the tunnel were as follows: 40% dynamite, $0.134 per pound; 60% dynamite, $0.159 per pound (powder was used in about the proportion of 30% of the former to 70% of the latter); 20-lb. steel rails, $72.24 per long ton; blacksmith coal, $27 per ton. The scale of wages is as follows: machine men, $4; shovelers, $4; blacksmith, $5; compressor men, $5.

AVERAGE TIME OF OPERATIONS

	Hr.	Min.
Picking down—Setting up	1	00
Drilling from upper set-up	4	30
Shoveling back—Lowering bar	0	30
Drilling from lower set-up	1	15
Tearing down	0	10
Blowing out holes	0	5
Loading	0	15
Total	7	45

DETAILED SUMMARY OF COSTS

	Total cost.	Cost per foot.
Labor:		
Machine men	$11,526.00	$3.953
Shovelers	10,711.00	3.673
Timbering	753.17	0.258
Drainage	123.00	0.042
Ventilation	224.50	0.077
Ties and wedges	394.60	0.135
Compressed-air line	210.00	0.072
Compressor men	3,398.35	1.166
Blacksmith and helper	3,546.50	1.216
Superintendent	2,554.00	0.876
Total	$33,441.12	$11.468
Supplies:		
Powder	$ 7,469.25	$2.562
Fuse	391.50	0.134
Caps	92.00	0.032
Candles	421.90	0.145
Blacksmith coal	364.50	0.125
Machine drills and parts	1,464.77	0.503
Drill steel	343.57	0.118
Timbers	150.00	0.052
Repairs on compressor	77.40	0.027
Oils	97.00	0.031
Miscellaneous	216.00	0.073
Total	$11,087.89	$3.802
Equipment:		
Muck sheets	$ 110.00	.....
Steel rails	1,290.00	...
Ventilators	225.00	.....
Ventilating pipe	960.00	.....
Compressed-air line	1,070.00	.....
Cars	400.00	.....
Total	$ 4,055.00	$1.391
Length of tunnel		2916 ft
Total cost		$48,584.01
Cost per foot		$16.661

NEW ST. PAUL TUNNEL THROUGH THE CASCADE MOUNTAINS*

The Chicago, Milwaukee and St. Paul Railway is now driving a tunnel 11,902 ft. long through the summit of the Cascades, between Rockdale, Wash., and Keechelus, 60 miles east of Seattle, which will effect a saving of 3.6 miles in distance, will eliminate 443 ft. of rise and fall and 1,239 deg. of curvature, the elimination of snow troubles being another important consideration.

The tunnel is being built for single track on a grade of 0.1 per cent. ascending from the east end for 2000 ft., and then descending on a 0.4 per cent. grade to the west portal. It is on tangent for the entire length with a 6 deg. curve at the east end and a short 3 deg. curve at the west portal. The new line crosses under the old about 1000 ft. in from the east portal.

METHOD OF CONSTRUCTION.

Before deciding upon the method to be adopted in driving this tunnel the relative advantages of the top heading method generally employed in this country and of the bottom heading, or European, method were studied. The bottom heading was determined upon as most economical because of the ability to trap the material above the first drift directly into cars, whereas the removal of a lower bench by large shovels or other power equipment was difficult if not impractical in a tunnel of this section and length.

An advance heading, 8 ft. by 13 ft., is first driven on subgrade at one side. A second crew then follows, breaking this heading out to the full width of 18 ft. This is timbered with 12 in. by 12 in. posts capped by 12 in. by 14 inch timbers at intervals of 5 ft. Following the timber, vertical openings are driven to the arch ring of the completed tunnel at intervals of 150 ft., and the excavation is pushed from these openings in each direction, drilling and blasting the entire face. The material is broken down on to the timbering and is trapped into narrow gage cars on the lower level.

In driving the heading four Ingersoll-Rand, 3⅝ in. piston type air drills, weighing 410 lb. each, are mounted on one crossbar and are operated simultaneously. This crossbar is set up about 4 ft. above subgrade. When working in ordinary rock 16 holes are drilled to a depth of 8.5 ft., 12 of which are above the crossbar, with 4 lifting shots beneath. Ordinarily the holes are not sprung, although in some instances when working in unusually hard rock it has been necessary to spring the holes twice. From 3½ to 9 boxes of 60 per cent. powder is set off in each set of 16 holes and is fired entirely with fuses. The average horizontal break is 7.3 ft. and the material generally is broken so that it can be handled readily. With the material encountered so far about 8 lb. of powder are required for each cubic yard of material shot from the heading.

The floor of the heading is covered with steel plates which are moved forward before each shot so that the material will fall upon them and be more readily loaded. In the lower heading and side drift a steel rocker car of one cubic yard capacity is used. This car is 3 ft. high and 4 ft. wide and was designed to operate in limited space. Peteler 1½ yd. side dump cars are employed for the removal of the material trapped down from the bench. Two tracks are laid with 56 lb. rail to the face of the heading, with frequent cross-overs. Horses haul the cars as far as the outer face of the bench, from which point they are handled with gasolene locomotives. All material from the tunnel is wasted at the portals.

When working in average material one round is shot every 12 hours in the heading. This time is divided approximately as follows: Three hours taking down roof and removing muck from the face of the heading. Thirty minutes setting up the cross bar and getting the drills into position. Seven hours drilling and removing the muck. Thirty minutes taking down machines and loading and firing shots. One hour clearing heading of smoke and gas. To accomplish this a force is employed on each shift consisting of four drill runners, four helpers, ten muckers, one nipper and one shift boss.

From six to ten bench openings are worked at one time, giving double that number of working faces. In this way the drill runners move from one face to another and work continuously, while on the heading they assist in throwing the material away from the face to expedite the work.

In general, the material encountered has been hard black slate. However, about 5,000

*Abstract from *Railway Age Gazette*.

ft. in from the west end a hard conglomerate with a large proportion of silica was encountered. With this considerable water was also found. The first 400 ft. in on the west end was a debris formation which also carried considerable water. However, between these two places sections as long as 1,500 ft. were found with no water whatever. Because of the hard character of the material on the west end it was necessary to replace the drills weighing 175 lb. with heavier ones weighing 410 lb., although on the east end new Ingersoll-Rand drills weighing only 110 lb., with a new valve motion, ("Butterfly,") and striking 600 blows per minute, are being tried out.

At the east end the work is being handled differently because of a large approach cut. To save time a heading is being driven at the upper level which will be continued to a junction with a bore from the west end. After the approach cut was completed, a second heading was driven at the track level, with shafts at various points extending to the upper heading to facilitate the handling of muck from the bench.

VENTILATION.

To provide ventilation and to remove the powder gases from the headings promptly one 12 in. ventilating pipe extends from the power house at the west portal to the face of the heading. Air is forced through this line by a high-speed fan with a capacity of 4,500 cu. ft. of free air per minute, direct-connected to a 25 h. p. steam turbine. A high-speed helper fan, with a capacity of 4,500 cu. ft. of free air per minute, direct-connected to a 20 h. p. electric motor, is located 2,500 ft. in from the west portal. To remove the dead air a 24 in. pipe line leads out from the bench. This is connected to a 72 in. slow speed exhaust fan driven by a 30 h. p. motor. As the bore is driven further in additional ventilation will be provided by adding more helper fans on both the exhaust and blower lines. A similar system is in use at the east end, the only important differences being that the exhaust fan is direct-connected to a 40 h. p. steam engine and the blower line is 17 in. in diameter, instead of 12 in., at the west end.

CONCRETE LINING.

It is planned to line the tunnel with concrete for its entire length before it is turned over to operation. This work was begun at the west end July, 1913, and is now being begun at the east end. It is anticipated that forces working from the two ends will meet about 8,000 ft. in from the west portal, and methods for transporting the material are being figured on that basis. All concrete is mixed at the portals and is hauled in trains of 4 steel cars of 18 cu. ft. capacity each. These cars are moved by a ¾ in. cable operated at a speed of four miles per hour. Each car is equipped with a cable gripping device which is automatically released at the proper point by a trip.

POWER PLANT.

The power plant at the west end consists of three oil-burning, 150 h. p. boilers, which operate two straight-line, single-stage Ingersoll-Rand air compressors, with a capacity of 807 cu. ft. of free air per minute each, and one straight-line, two-stage Ingersoll-Rand air compressor with a capacity of 790 cu. ft. of free air per minute. These boilers also provide steam for a 200 h. p. engine belt-connected to a 100 kw., 500-volt d. c. generator, furnishing power for the motors operating the fans and for the Leyner drill sharpeners and other tools in the shops. This generator also supplies current for lighting the tunnel, using a three-wire system of distribution, which allows a voltage of 250 to be used. A 3 kw. balancing set is installed in this circuit. Extension cords are provided at the various faces where blasting is being done.

At the east end three 125 h. p. boilers are installed. These boilers also operate on fuel oil, which is delivered from the main line one-half mile distant into two 20,000 gal. timber oil sumps and is then carried through a 6 in. wood stave pipe line to a 35-barrel service tank at the power station. These boilers operate two Laidlaw-Dunn-Gordon duplex two-stage air compressors with a capacity of 1,030 cu. ft. of free air per minute each, and one 180 h. p. engine direct-connected to a 75 kw., 500 volt, d. c. generator. The lighting system here is practically the same as that at the west end.

ORGANIZATION.

The construction of this tunnel is being handled entirely by company forces. With the exception of the shift bosses, who work 12 hours, the work is carried on continuously in three shifts, six hours on and 12 hours off. The concreting force is divided between two shifts of 10 hours each. Normally, about 250 men are employed in the tunneling operations in each end, and 80 men are engaged in placing the concrete lining at the west end.

The men engaged in driving the heading

are paid a bonus based on 10-day periods For each foot of heading driven over 100 ft. in this period each man is paid one hour overtime. This practice has been found to work out very satisfactorily, as it tends to expedite work and to hold the men as well. Under favorable conditions the men have made as much as 60 hours overtime in 10 days. The best progress made in the west heading for one month to date was 450 ft. and on the west bench 600 ft. Among other measures taken to safeguard the men, a pulmotor with several oxygen helmets is provided at each portal.

The heading at the west end of the tunnel is now in about 6,500 ft., while that at the east end is in about 3,500 ft. At the present rate of progress these headings should be connected about July 15, and the tunnel should be completed, including the concrete lining, by the end of the year. About 3,100 lineal ft. of concrete lining has been placed to date. comprising about 18,500 cu. yd.

The work is being done under the direction of C. F. Loweth, chief engineer, and E. O. Reeder, assistant chief engineer. J. I. Horrocks is engineer and superintendent of construction in direct charge of the work on the ground.

WANTED—AN AIRBRAKE STORY

For the purpose of obtaining from railroad officials and employes authentic information of interest and value the Westinghouse Air Brake Company, of Wilmerding, Pa., offers $2000, divided into prizes of $1000, $500, $200, $150, $100 and $50, for the best written narratives of airbrake performance in the actual service for any period. The awards will be made by an independent committee of three judges, consisting of prominent persons not associated in any way with the Westinghouse interests. The stories must be based upon actual personal experience or observation of the writer or on information obtained first hand from railroad men who actually know and can substantiate the facts. No article shall contain more than two thousand words. It should be addressed to the "Judges of Prize Contest," Room 2121, 165 Broadway, New York City. For additional information see the booklet available on request from the Westinghouse Air Brake Company, Wilmerding, Pa., containing the rules and conditions governing the competition. The closing date is August 1, 1914.

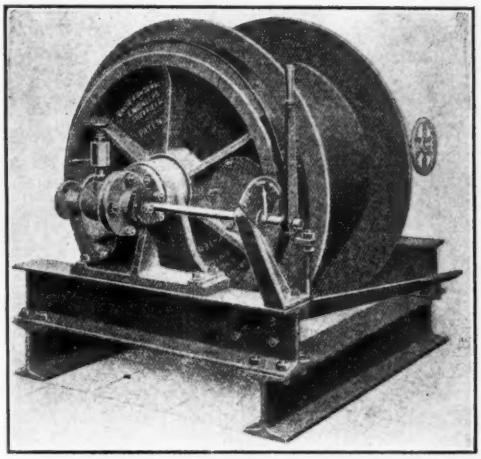


FIG. 1.

A SELF CONTAINED COMPRESSED AIR HAULAGE AND HOISTING DRUM

A novel and interesting haulage and hoisting drum, built by David Ashton & Co., Sheffield, Eng., is shown externally in the half tone, Fig. 1, and in detail in the line cuts following. The drum is driven by compressed air and the motor, consisting of three single acting cylinders thrusting on a fixed crank pin, is entirely within it. The only external parts, as seen in Fig. 1, are the vertical starting and reversing lever, the friction clutch and the hand brake.

Fig. 2 is an unshaded sectional elevation of the drum. The non-rotating crank shaft contains two air passages, A and B, communicating with the air chest C through the slide valve D can be moved to admit air through either of these passages and at the same time connect the other with the exhaust. This valve is used only for reversing or stopping the engine and, by means of a rack and pinion, is operated by the control lever.

Two ports shown in section in Fig. 3 form a communication between the passages A and B and the passages E attached to and revolving with each cylinder. The flaps F F^1 perform the air distributing function. If, say, the passage A is acting as inlet, the air pressure keeps the flap F in the position shown in Fig. 3, and the cylinders, rotating in the direction of the arrow, the air is cut off at about two-thirds stroke. The flap F^1, however, partially covering the exhaust passage B,

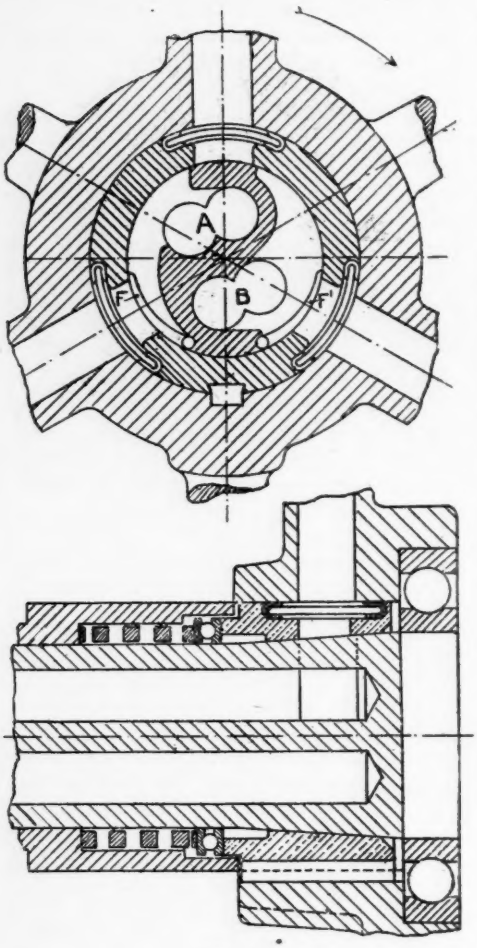


FIG. 3.

automatically falls and allows the exhaust to continue throughout the stroke. On reversing the engine the flap F falls and F^1 rises, giving the cutoff on the admission stroke.

The cylinders are carried between two discs mounted to turn on the crankshaft on ball bearings. On the boss of the right hand disc is fixed a phosphor bronze pinion J gearing into a larger pinion K, which latter is mounted in ball bearings on an arm attached to a sleeve L. The sleeve L surrounds the fixed crank shaft, and on it is keyed the clutch pulley M, which can be held or released by a friction band operated by a hand wheel on the right side of the drum. When the sleeve L is held by the clutch, the movement of the pinion K is transmitted to an internal gear wheel mounted on the inner side of the drum side P through the pionion N, thus revolving the drum with a double reduction of speed.

When the clutch M is released the sleeve L revolves with the engine, the pinion N runs idly around the interval gear and the engine and the drum can rotate independently. This arrangement allows the drum to run freely when lowering down an incline.

The engine can be easily removed by taking off the pedestal supporting the clutch and the drum side P, when the complete engine and gearing can be slid out of the drum. The ease and accuracy with which the drum can be manipulated is remarkable—by working the reversing lever a movement of a few inches of the drum can be obtained without difficulty, and the engine can be reversed under load at full speed without danger. Practically all moving parts run in an oil-bath absolutely free from dirt; the over-all dimensions are less than those of any gear having external engines; there is no possibility of the rope fouling the gearing or of fingers getting trapped; no interference with the engine by unauthorized persons can take place; there are no stuffing boxes; on account of the simple cut-off arrangement, the air consumption is low, and the power in relation to cylinder diameter is increased by the high speed at which the engine runs and the efficiency of the gearing, which is perfectly lubricated.

The drum illustrated is the smallest of three sizes made, particulars of which follow:—

	Size.		
	No. 1	No. 2.	No. 3.
Drum diameter ..... Inches	18½ ...	26 ...	33
Barrel width Do.	16 ...	20 ...	24
Cylinders ...Do.	5 by 2½ ...	6½ by 3½ ...	8 by 4½
Cubic feet of air used per minute.....	50 ...	84 ...	146
Pounds pull on rope	1,000 ...	1,800 ...	3,000
Horse-power	9 ...	16 ...	27
Outside dimensions...Inches	30 by 30 by 30...	42 by 42 by 42...	54 by 54 by 42
Revolutions of engine	700 ...	550 ...	400
Weight ...Cwt.	15 ...	25 ...	35

What is said to be the highest dam in Europe has just been completed across the River Bober, near Hirschberg. It is 204 ft. high, 164 ft. wide at the base, and 24 ft. at the top, with a curved plan, concave to downstream, of a radius of 820 ft. It contains about 9,000,000 cu. ft of stone masonry and cement. There are a spillway 280 ft. wide and two outfalls at the base 4 ft. 11 in. in diameter.

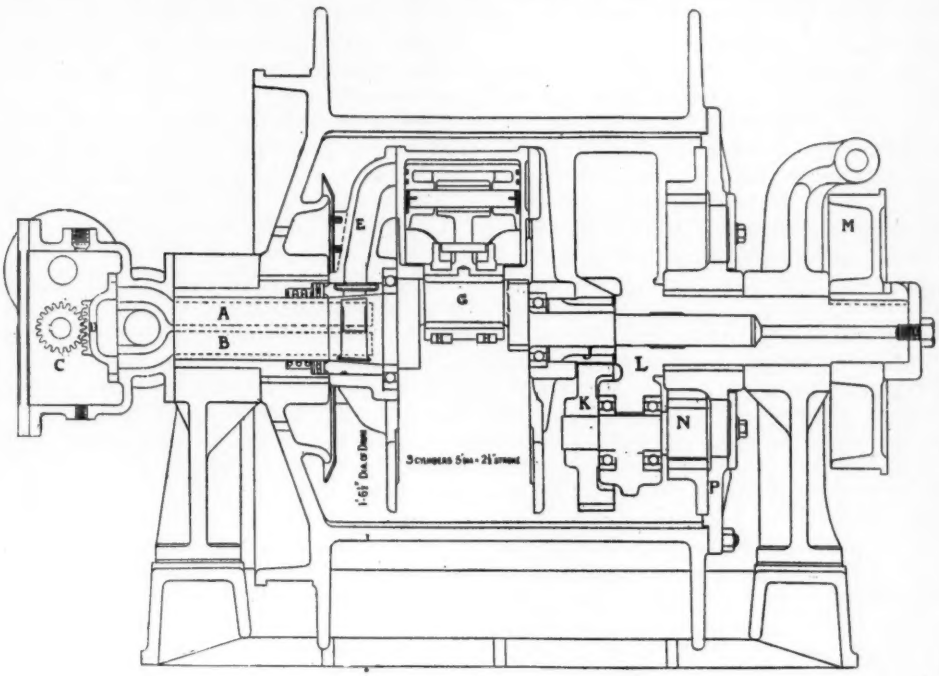


FIG. 2.

OXY-ACETYLENE CUTTING AND WELDING

BY H. P. HARDING.*

THE CUTTING OPERATION.

In the cutting torch several small oxy-acetylene jets pre-heat the work for an additional jet of oxygen, which does the cutting by a high rate of oxidation. Part of the metal is removed as an oxide, and the heat of combustion melts the rest so that it runs out of the cut.

Theoretically the proportion of the gases is two of acetylene to five of oxygen, which combine to form four volumes of carbon dioxide plus two of water vapor. This reaction is not completed in the inner cone, because the temperature is above their disassociation point, so further combination occurs in the outer envelope. Most of the oxygen in this second step is taken from the surrounding air.

The tip of the inner cone is the working point of the flame. Although its total heat is less than that of the envelope, the outer being very much larger, the heat in the envelope is not wasted. Instead, it serves three functions: to pre-heat the work for the inner cone; to prevent the inner cone being cooled by the inert nitrogen of the air; and to protect the molten metal from oxidation, the combining carbon monoxide and hydrogen having a greater affinity for oxygen than the metals.

*Illinois Gas Association.

THE WELDING OPERATION.

In operating the welding blowpipe the flames should be kept neutral; that is, there should be no excess of acetylene, which would tend to carbonize the metal, nor should there be an excess of oxygen, which would tend to oxidize it. Excess acetylene can be detected by the double inner cone, one cone being longer and less luminous than the other. An excess of oxygen can be detected by the feathery end of the inner cone. Further, a carbonizing flame will cause the metal to glow, while an oxidizing flame will cause the metal to boil. The amount of the gases admitted to the blowpipe is controlled by a regulator, which serves the function of a reducing valve to maintain any set constant pressure, not exceeding that of the source of supply. A gage on the blowpipe side of the regulator indicates the torch pressure. A gage can be used on the supply side of the regulator to indicate the

depletion of the compressed gas in the cylinder.

The high temperature of the oxy-acetylene flame enables the operator to bring the metal to a molten condition before the heat is conducted or radiated away. Some of the heat is conducted away, but it is not entirely lost since it assists in reducing trouble from expansion and contraction in the surrounding body. The envelope starts heating the body in advance of the actual work at the point of the inner cone.

EXPANSION AND CONTRACTION STRAINS.

Internal strains are always set up in every process of welding, due to the expansion and contraction when a metal body is heated and cooled. When the parts are restrained members of a structure, the internal strains set up are often sufficient to crack the metal. This is more especially true when welding hard brittle, inelastic metals, such as cast-iron. When the local strains exceed the strength of the material, fracture is bound to occur in one or more sections of the body. The more ductile the material is, the better it is capable of withstanding strains of this sort.

To relieve a welded piece of these strains, it is desirable to pre-heat before and re-heat after welding. Molecular rearrangement will then bring forth a redistribution, if not an actual elimination of the excessive strains. This treatment is very essential for cast-iron, but it is not as important for steel or wrought-iron. For large work it is usually impossible to heat the entire body. However, it is very desirable to heat the work for a considerable area around the welded portion, both before and after welding.

WELDING SHEET METAL.

In welding sheet metal of greater thickness than ⅛ in., it is advisable to cut a "V-groove" along the edge to be welded to permit penetration of the flame. It is usually necessary, except with thin sheets, to add metal from a filler rod or wire of the same or similar material. After the metal at the joint is in a running condition molten metal is added drop by drop from the filler rod until the groove is entirely filled. Sometimes an excess is added to insure the strength of the weld. If dissimilar metals are to be welded, a welding rod of the one which welds at the lowest temperature is used so that the added metal will not chill when falling upon the molten metal.

Flux is used when welding cast-iron, aluminum, brasses, bronzes, etc., to prevent oxidation, to remove the scale, and make the metal more fluid.

The strength of the weld is invariably greater than 85 per cent. of that of the original material. This difference is due to the inferior material of the welding rod or to the internal strains set up by expansion and contraction.

The structure of the weld is not quite as homogeneous as other parts of the piece welded. This is controlled largely by the skill and workmanship of the operator who can, at will, make the weld more or less homogeneous. By hammering at the right moment on the welded part, the metal can always be made denser, thus increasing the strength of the weld. A skilled welder uses the hammer as freely as he does the blowpipe.

It has been advocated of late to license operators and plants for boiler work. At the present time this would not be practicable because there are a number of cheap equipments on the market which it would not be possible to give proper instructions to the operator.

It is safe to say that one system or the other of flame welding is rapidly making its way into every branch of the metal working art. This is particularly true of oxy-aceylene welding. From a standpoint of the volume of work done, America leads the world, with Germany second, France third, and England a rather poor fourth. In scientific research and special development Germany leads all other countries. This is partly due to the fact that the German government has established schools at various places where the art is taught as one of the applied sciences.

PIPING.

As one feature of the work being carried on in Germany it might be mentioned that piping of all sizes and character is now being made by rolling from flat plate and welding by means of the oxy-acetylene torch. Piping is also being laid without the use of threads or flange joints. In this way they are enabled to use pipe of about one-half the thickness of our standard pipe, thereby saving greatly in material costs. To show what the German government thinks of this class of work, it is merely necessary to mention that at Cologne in the Palace of Justice Building, recently

completed, there are nearly seven miles of piping in which there is not a single threaded joint, all being welded by oxy-acetylene.

At the Panama-Pacific Exposition, which will soon be held in San Francisco, a very interesting feature of the construction of gas and water piping is that every joint throughout the entire grounds has been welded with the oxy-acetylene blowpipe, thus eliminating the use of a large amount of additional iron necessary for fittings and simplifying the construction of gas piping considerably throughout.

We understand that in Germany a great deal of piping of all kinds is welded, even in large buildings and manufacturing plants. When the operator wishes to connect a branch to the main line, he merely applies the cutting blowpipe, cutting out a hole of the proper size and welding it to a nipple. He has a small portable equipment and the work proceeds very rapidly and not only is the line absolutely tight, but the weld is of nearly as great strength as the original piping.

IN THE GAS BUSINESS.

An instance which should be of considerable interest to the gas manufacturer is the welding of lamp posts in Dayton, O. During the recent flood in Dayton about 150 of the ornamental cluster lamp poles were broken off about 18 in. above the ground. The breaks were not due to defective castings, but to the heavy objects which were swung against the poles by the current through the streets. To take up the concrete in the street and reset the poles would have been a very expensive operation, therefore the oxy-acetylene blowpipe was used, and the poles welded efficiently and economically. A special derrick was used on which were mounted an acetylene generator and the oxygen cylinders with the necessary tools. The wagon was backed up to the stub of each pole, the broken part raised to its original position, the old breaks were matched up and the joints prepared for welding. The weld was probably stronger than the original casting, as one-eighth inch fillet was added to the metal at that point.

In Canton, Ohio, and in many other cities there are a great many lamp posts which are constructed of sheet metal attractively fluted and pressed to make a well-designed post. In the manufacture of these columns, a sheet of the proper size is selected, suitably tapered and the longitudinal seam welded with the blowpipe. After the welding has been accomplished the fluting is placed in the metal by use of dies of various kinds, the base and top of the columns are suitably pressed to give a pleasing appearance. Such posts are very much lighter than the ordinary castiron posts, and are practicably indestructible and, if desired, may be filled with cement or concrete, which gives a very substantial construction.

In direct connection with gas manufacturing plants there are of course many operations to which the blowpipe may be applied with economy. Among these are the repairing of furnace door frames, large heavy posts, hydraulic rams, pumping machinery, wrecking of old gasholders, structural work, etc., cutting of manholes through steel tanks or required repairs to boilers, etc., etc.

A gas pipe joint which has been recently developed abroad and is giving good service, is called "Stewart's patent long sleeve welded joint." This is made by tapering slightly the spigot end of one pipe, which is a driving fit, into a correspondingly tapered socket or sleeve on the next; the latter having a slightly belled mouth on which the welded joint is made. The close fit of the two tapered surfaces has the effect of relieving the actual weld of transverse bending stresses. The belled mouth serves a two-fold purpose—first, of facilitating the entry of the spigot end of one pipe into the socket end of the next; second—of affording a long contact surface for the weld.

In conclusion, it may be conservatively stated that the flexibility of the blowpipe is such that there are an infinite number of uses for it in almost every plant where iron and steel structural work or machinery is dealt with.

A committee of the Town Council of Berlin is investiagting a project for the construction of a tunnel for the use of street cars under the city's most fashionable street, "Unter den Linden." The carrying out of the project would relieve a growing congestion and greatly improve the appearance of the important thoroughfare. The tunnel would have parallel eastern and western sections, one northern entrance for four lines and two southern entrances for two lines each.

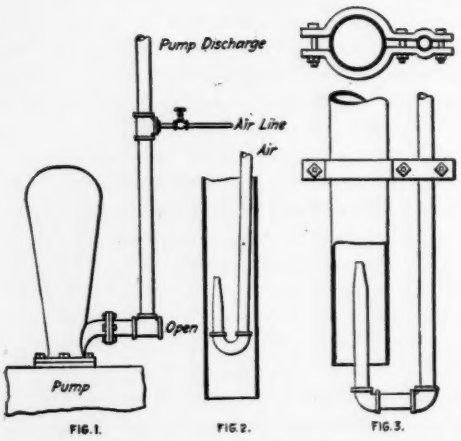


FIG. 1. FIG. 2. FIG. 3.

THE AIR LIFT FOR SHAFT UNWATERING

BY ARTHUR O. CHRISTENSEN.

A shaft can usually be unwatered more quickly and cheaply with an air lift than with pumps. It is therefore advisable, before allowing a mine to flood, to connect the air line to the discharge of the pump line as near the bottom of the shaft as possible, preferably a few feet above the pump, as indicated in Fig. 1. If there is a tee where the line joins the pump this should be left open. If there is not a tee the line should be disconnected from the pump.

To start unwatering, compressed air is simply turned into the air line and the pump discharge line begins to work as an air lift. The diameter of the air line where connected to the water pipe should be about one-fourth of the latter.

Even if the pump is one which can be started while drowned, so that an air lift attachment seems unnecessary, still it is desirable to have the connection made as described, for there is no knowing how long the pump may be submerged or whether it will work when the air supply is turned on. In such a case, however, it is not necessary to make any opening in the discharge line, since, if the air lift is to operate without the pump, it can suck water through the pump valves. Both lift and pump can be used, one helping the other. The air lift relieves the pump of a portion of its work by diminishing the head in the discharge, or, looking at it from the opposite standpoint, the pump aids the lift by supplying its suction end with water at a pressure which may be greater and cannot be less than would be the case were the pump not to act. Conversely if it is found that a pump is not able to lift its water to the point of discharge, the suction end being all right, a small amount of air admitted to the discharge line just above the pump will cause it at once to speed up.

In most cases, however, it is too much to expect a retiring management to leave a mine in such shape that it is necessary only to start up the compressor in order to unwater the property. The question is how to unwater the shaft as it stands.

Frequently there is a pipe line running straight down the shaft. Whether the bottom of this be open or closed, and whether there be a pump attached or not, the air lift can be operated, so long as the line is straight enough to allow a pipe to be run down the inside. Fig. 2 represents the lower end of the inner pipe. If no return elbow is at hand, two elbows connected by a close nipple will answer. The nozzle is made by heating one end of a short pipe and forging it down to about three-fourths or one-half its original diameter. This arrangement can suck water through a drowned pump, although of course not so readily as if there were no obstruction.

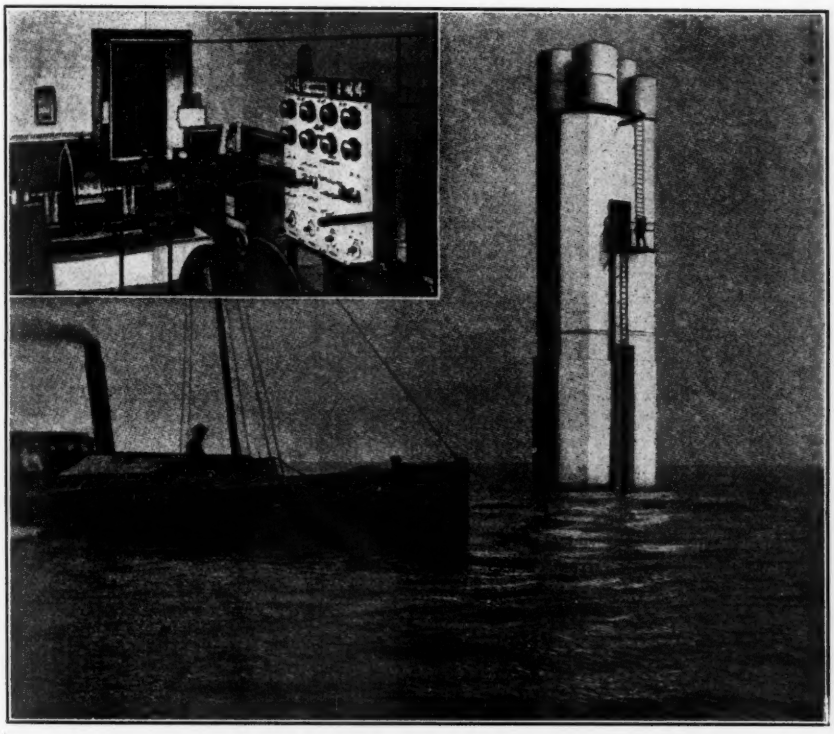
Where a suitable pipe is in the shaft but is closed by a valve or otherwise, a charge of dynamite can be lowered by a small pipe within the larger, and the charge exploded by electricity—one ordinary dry cell will set off an exploder—thus breaking the pipe. The saving by using an air lift for the job is assumed to be more than the cost of repairs to the pipe line later on.

In case no suitable pipe for the water discharge is found in the shaft, a simple air lift can be dropped down a vertical shaft or can be lowered in an inclined shaft either on the truck or simply on a plank laid across the rails.

A 2 in. and a 1 in. line make a convenient size for such a lift, as is shown in Fig. 3. At intervals of from 15 to 30 ft. the two lines are strapped together as indicated. This arrangement will operate either vertically or on an incline. The discharge can be carried through elbows, but two 45° elbows give better results than a single 90°. As soon as it is noticed that the ratio of water to air being discharged has decreased considerably, the lift must be submerged more, or, if this is not possible, the height of its discharge must be diminished by installing a pump as near the water as

possible to throw the water from the lift to the surface.

With 100 lb. of air pressure, such a lift as indicated can raise water 200 ft. with a 20-ft submergence, or can lift 50 ft. with almost no submergence at all. The air issuing from the nozzle serves as an ejector to suck up and carry the water along with it. Air lifts can be compounded to raise water any heights with any submergence, down to almost nothing, but in general a pump is preferable to such a complicated arrangement.—*Eng. and Min. Journal.*



LIGHTHOUSE OPERATED FROM THE SHORE.

A LIGHTHOUSE WITHOUT ATTENDANTS

BY H. J. SHEPSTONE.

The only unattended lighthouse built on a wave-washed rock, boasting of a powerful fog signal and all the apparatus associated with a fully equipped light station is the recently completed Platte Fougère tower, marking the entrance to Russell Channel, which leads to St. Peter's Port, the capital of the island of Guernsey, in the English Channel. The tower guards dangerous reefs which have for years been a menace to shipping, more particularly in foggy weather than at night. The tidal currents and the great rise and fall of the tide, with its swing of 30 feet at this spot, also make navigation extremely difficult.

The possibility of erecting a stone tower to accommodate keepers was soon found to be out of the question, not only owing to the great cost that would be involved in constructing a rock lighthouse that men could live in, but also on account of the small area of the rocks. The difficulty was overcome by equipping one of the rocks with an 80-foot tower large enough to hold motors, compressors, fog horn and light, which are all controlled by a submarine cable from the shore. This lighthouse, with its wonderful array of electrical devices for warning and guiding the mariner through the dangerous channel, rises from a rock known as Platte Fougère, always submerged except at low water.

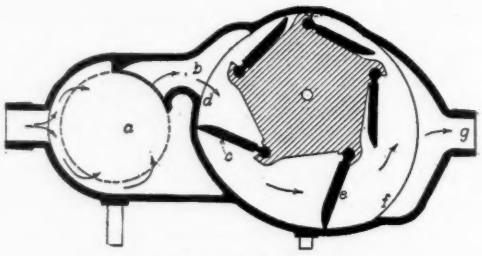
On the entrance level is a compartment containing an electric motor and air-compressor, while on the floor immediately above is a dup-

licate installation. The syren projects through the top of the tower, the trumpet being so turned as to throw the sounds in a horizontal direction over the water. On the top of the tower is a small automatic acetylene gas plant and lamps. All these devices, many of which are the invention of Mr. E. C. Catford, are controlled from the shore station, 1¼ miles distant, by means of a submarine cable specially made for this work. In fog it is desirable to know that both light and fog signal are working satisfactorily. Accordingly Mr. Catford designed special alarms which would inform him of their behavior. At a distance of some 15 feet from the lantern he placed a selenium cell electrically connected with an alarm bell in the shore station. So long as the light flashes every ten seconds on the cell the bell does not ring, but should fog obscure the light or the light go out for any reason, the bell at once commences to ring, thus giving the alarm. In the same way a bell rings in the engine room at every blast of the syren. The signal comes instantaneously, the actual sound of the blast itself reaching the shore five seconds later.

The shore station is situated at a point known as Doyle Fort. Here a dwelling has been erected for the keepers, adjoining which is the engine house. The machinery includes two oil-engines which drive three-phase alternators, and an air-compressor for working the land syren should that be required. In the tower itself there is a simple switch operated by an electro-magnet, whereby motor-driven air-compressors are thrown in and out of action. Thus, at night the light can be automatically turned on, and at sunrise automatically extinguished. In the same way the fog signal can be set in motion or be discontinued at will.—*Scientific American.*

A VOLUMETRIC AIR METER

The cut shows the essential features of a volumetric compressed air meter made by the Kreutzberg Meter Company, Chicago, Ill., for measuring and recording the actual volumes of air, regardless of the pressure of it, which may be flowing through a pipe at any given time. It may be connected into a service pipe anywhere the same as a stop-valve, a check valve or any other fitting and then as the air flows through the pipe its record will be made. Its handiness for observing the consumption of a rock drill, a pneumatic hammer



VOLUMETRIC AIR METER.

or any other tool when in use will be appreciated. The meter should be used only in a horizontal pipe and the axis of the drum should also be horizontal, and if free air consumption is to be ascertained for any purpose, a recording pressure gage also would be essential.

Referring to the cut, the air enters on the left, passes into the screened chamber *a*, and from there it passes into the body of the meter through the passage *b*. It impinges against the vane *c*, causing the drum to rotate. When this vane has passed the point *d* a fixed volume of air is contained between vanes *c* and *e*. As soon as the latter reaches the outlet *f* the air is free to pass out into the pipe line at *g*, the contact of the lip of the drum with the case preventing it from following the drum any further. A counting train is connected to the drum spindle. The amount of energy required to rotate the drum must be quite small, and if the apparatus is carefully fitted to begin with there should be very little leakage. The meter is made of bronze throughout and normally is good for any pressure up to 150 lb.

CARBON DIOXIDE AND THE CRITICAL PHENOMENA OF GASES

Carbon dioxide is a colorless gas, which possesses a faint taste and odor. It may be liquefied relatively easily, since it boils at—80° under atmospheric pressure. The critical temperature is 31.1° and the critical pressure is 73 atmospheres. The volume of one mole of carbon dioxide at the critical temperature and pressure is 95 cc., and is known as the critical volume of this substance. The critical phenomena were first studied in the case of this gas. There is a fundamental difference between a gaseous substance at temperatures above and below its critical temperature. In the former case, the substance remains a gas, no matter how great the pressure to which it

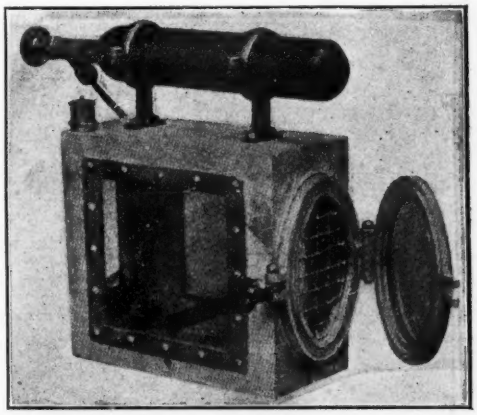
is subjected. The density of the highly compressed gas may thus be made even greater than that of the substance in the liquid state at lower temperatures. If the temperature is at or below the critical value, we have seen that increasing pressure results in the partial or complete conversion of the gaseous substance to a liquid. The pressure which just suffices to produce liquid is definite for each temperature, being greatest for the critical temperature, and progressively lower for lower temperatures. This fundamental difference is expressed in the names gas and vapor. A gas is a gaseous substance above its critical temperature, and a vapor is a gaseous substance below its critical temperature. Thus, at ordinary temperatures and even up to 31°, carbon dioxide is a vapor. At higher temperatures it is a true gas.

Carbon dioxide is an important article of commerce, being used principally for carbonating beverages. The annual production in the United States is over 10,000 tons. It is marketed in the liquid state, in strong steel cylinders, since the pressure of the vapor in equilibrium with the liquid at ordinary temperatures is about 1,000 pounds per square inch. Carbonated water is prepared by dissolving (saturating) water with the gas under a pressure of about 225 pounds per square inch. When this water is drawn off, part of the gas escapes, since the pressure is reduced, and causes the liquid to effervesce.

If liquid carbon dioxide is exposed to the air in open vessels it boils vigorously. The heat necessary to cause the change from liquid to vapor (the heat of vaporization) is absorbed largely from the liquid itself. After this cooling has lowered the temperature to—78.2°. the liquid which remains is converted into solid carbon dioxide. The solid then continues to evaporate without first melting, i. e., it sublimes. It is, therefore, not possible to keep liquid carbon dioxide in open vessels, as the change to solid ensues. If the pressure on solid carbon dioxide is increased, it is found to melt at about—57° C.

Liquid carbon dioxide is a colorless liquid, which is only slightly soluble in water. It is characterized by a very high coefficient of expansion, showing greater changes of volume with changes of temperature than any other known substance. The coefficient of expansion of liquid carbon dioxide is greater even than that of gases.

Solid carbon dioxide is a white solid, which, as we have seen, sublimes at—78.2°. If the pressure of the vapor above it is reduced, it sublimes at still lower temperatures, and by causing the sublimation to proceed in a good vacuum, temperatures as low as—100° can be reached. A mixture of solid carbon dioxide and ether (the latter being used to effect good contact with the object to be cooled) is called "Thilorier's mixture," after its discoverer. It is used for obtaining temperatures down to the subliming point of the solid carbon dioxide (i. e., to—78.2°.)—*National Laundry Journal.*



CANARY AMBULANCE.

A PORTABLE ANIMAL REVIVER

Canaries and mice, as our readers know, are now frequently carried by miners where there is reason to suspect the presence of carbon monoxide or other dangerous gases. When a bird is overcome, thus giving timely warning to the men, it is not pleasant to think that that is to be the last of it, unless it is immediately carried out to where the air is pure. It might also be desirable to use the bird-test over and over again within a short space of time as different parts of the mine were traversed, and so the cage here shown has been devised for reviving the bird by the use of oxygen.

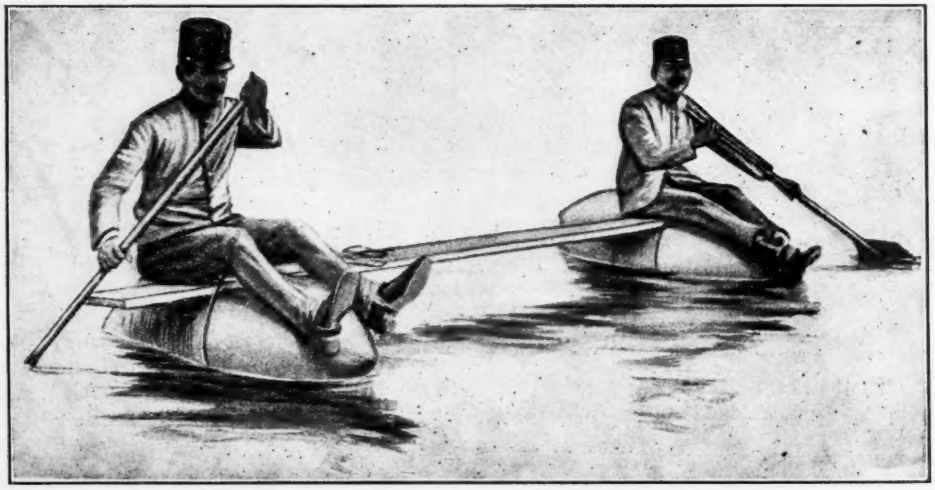
The cage is made of metal and it has glass windows on three sides of it. In front is an oval opening with a coarse wire netting and a tight-closing door. Above the cage is a cylinder containing oxygen under pressure, this cylinder also being utilized as a handle. When the door is closed a little oxygen admitted to the chamber restores the air to breathable condition and the bird revives. An outwardly

opening valve at the top prevents any excess of pressure within the chamber. The cage is made by Siebe, Gorman & Co., London. H. N. Elmer, 1140 Monadnack Block, Chicago, is the American agent.

SOME BLOWERS IN THE AUSTRIAN ARMY

The engineer corps of the Austrian Army carry air bags which can be used in place of boats or as pontoons for emergency bridges. The bags made of waterproof canvas, are about 5 ft. long and half as wide and for transportation form a compact roll. When wanted for use they are unrolled and blown full of air the orifice then being closed and secured by a clamp. A plank 10 or 12 ft. long lashed to two of the bags will support several men. Spaced at proper intervals with suitable planks they form a serviceable bridge. The half tones on this page are reproduced from Popular Mechanics.

BLOWING UP THE BAGS.



USED AS A RAFT.

ANIMAL INTERRUPTERS

The earwig which held up the London District Railway service recently, by short-circuiting the electric-signalling apparatus, was unwittingly emulating the spider which on June 4th, 1908, dislocated the traffic on the Irish Great Northern Railway for nearly two hours. The electric staff instrument failed, and ultimately the cause was traced to a spider which had lodged itself between the lever and the contact points. Last year a train was derailed on the London and North-Western Railway owing to a hedgehog having been caught between the point and side rails and preventing them closing properly. A Mississippi steamer was recently stopped by an invasion of willow-bugs, which made for the engine-room and clogged the engines, while a swarm of bees in December, 1912, took possession of a South African railway station, drove off the passengers and officials, and prevented any trains entering until they took their leave in the evening.—*The Engineer.*

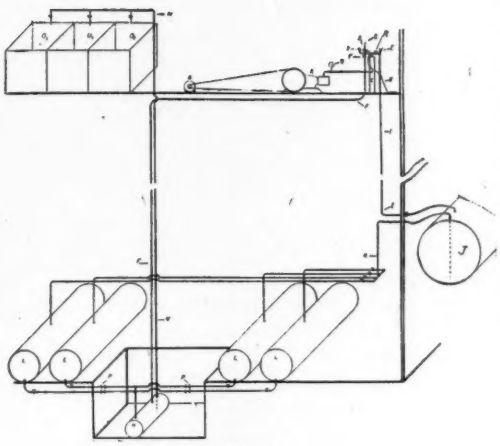


FIG. I.

HANDLING CHEMICAL SOLUTIONS IN QUANTITIES

BY C. C. PHELPS

When acids and other chemical solutions of a corrosive nature must be lifted or conveyed from one place to another, the relative advantages of different methods of accomplishing the desired result cannot be decided on the questions of initial or operating costs alone, for the service may be so severe on certain types of apparatus as to render them practically useless in a short time. Frequent delays for repairing may also occasion great losses due to the stoppage of manufacturing processes. Ordinary reciprocating and rotary pumps are often out of the question, even when constructed of special material of a non-corrodible nature.

A device known as a montejus, which is operated by either air or steam pressure, has been used to some extent for this purpose and is fairly satisfactory; but it is open to the objection that it has valves, floats and other moving parts in contact with the fluid. Other devices, using air or steam pressure, employ either the injector or siphon principle for their operation with more or less success, depending upon the requirements, but they, too, have certain limitations in practical use.

For handling chemical fluids in large quantities the method illustrated herewith has certain advantages which will be apparent from the description. The system illustrated in Fig. 1 is in use in a large Massachusetts textile mill, for raising heavy commercial oil of vitriol to bleaching vats on the third floor of a building. Compressed air is used, not only for this purpose but also to empty the acid from the tank cars which are brought alongside of the building. The engineers in charge of this plant consider that the method which they have adopted is admirably adapted for its purpose.

Referring to the diagram, O_1, O_2, O_3 are lead-lined bleaching vats; they are partially filled with pure water, after which 100 gal. of the concentrated sulphuric acid is raised and added slowly to the water, the contents being stirred while the acid is being added; then a small quantity of hydrochloric acid is added by hand from a carboy, after which the bleaching solution is ready for use.

Located near the vats is an air compressor *A* driven by a 2½-hp. belted motor *B*. The compressor cylinder has a displacement of 15 cu. ft. of free air per minute and operates normally at 40 lb. per square inch air pressure. The compressor, gauge, receiver and controlling valves are shown in the photographic view, Fig. 2.

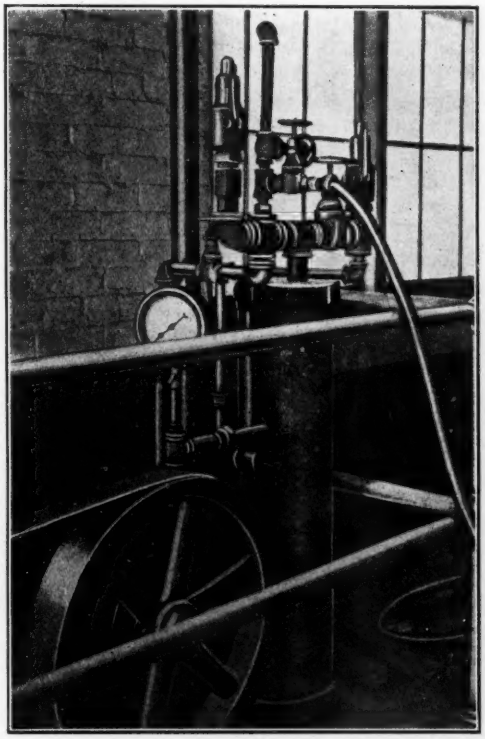


FIG. 2.

The compressor discharges into a length of pipe *C* of large diameter, which acts as a receiver to steady the pressure in the line. Gauge *Q* indicates the air pressure in the line. Two air lines, *I* and *F* lead from the receiver. By closing all valves on the left of the receiver outlet and opening valve *R*, pressure is put on pipe line *I*. The latter line leads to a connection whereby air pressure can be put on the tank of an acid car *J*. Safety valve *E* is set for 15 lb. per square inch, so no pressure in excess of this amount can be put on the car tank. The car tank's outlet is coupled with pipe *K* leading from the outside of the building to four heavy iron reservoir tanks *L* in the basement of the mill. Each of the tanks *L* has a capacity of 3,500 gal. and is provided with air vents. With an air pressure of 15 lb., it requires about two hours to empty the car, capacity of which is usually about 5,000 gal.

Pipes lead from the bottom of the reservoir tanks to the top of a 100-gal. iron supply tank *M* placed a few feet below. In each of these connecting pipes is a check valve *P* to prevent the acid from returning to the large tanks. Leading from the top of the small tank is the air pipe *F*. Normally this serves as a vent, allowing the acid to flow into the small tank and fill it. When a charge of acid is wanted, this vent is closed by a valve *S* near its outlet *G* and air pressure is put on this line by opening valve *T*. The acid immediately begins to flow from the bottom of the 100-gal. tank up pipe *N* to the bleaching vat, a height of about 40 feet. About five minutes is required ordinarily to pump the 100 gal. with an air pressure of 40 lb. Safety valve *D* is set for 50 lb. A short length of hose *H*, connected to the air system, is used for cleaning and similar purposes.

With this system there is no mechanism to come in contact with the acid and get out of order. When a charge of acid is wanted, the motor is started by simply throwing over the starting switch, and then the proper valves are opened. The charging tank will not deliver more than a hundred gallons at a time, although less than that quantity could easily be obtained by shutting the valve at the vat at the proper time. The air pressure on the tank being constant the rate of acid flow will be constant, and the quantity of acid lifted in a given time will be proportional to the time required for raising it. Pressure is put on the line only when actually pumping, hence the economy of operation is evident The air pressure is on only the small tank and the lines leading to and from it. The larger tanks are never under air pressure, and hence any trouble that might develop through leakage in such large tanks is avoided. The acid, being in concentrated form, does not cause any trouble from corrosion in the iron tanks or pipes, as might occur with dilute acid.

The flow of acid by gravity from the reservoirs to the small tank is entirely automatic, and reversal cannot occur. No attention is given to the apparatus in the basement, the entire control being where the acid is used. The extreme simplicity of the arrangement described should suggest its use for a large number of industrial processes, perhaps with modifications to suit each case. *Metallurgical and Chemical Engineering.*

SPECIFICATIONS RELATING TO COMPRESSED AIR IN TUNNEL WORK

The construction of additional subway tunnels under the East River, New York, has required the preparation of specifications covering the new contracts. These are very comprehensive and specific and embody details of requirement suggested by the latest experiences in similar work. The requirements relating to the use of compressed air and the safety of the workers under pressure are much extended, and embody important requirements beyond those found in existing laws. These, it is understood, were specially prepared by Mr. Frederick C. Noble, division engineer.

There are nearly two miles of double lines of single track tunnel excavation under compressed air, most of it shield work with cast iron lining. A large portion of the work is in sand at a maximum depth of 90 ft. below mean high water.

The first requirements are as to the sufficiency and the reliability of the mechanical equipment. The contractor must install air compression, hydraulic and electrical machinery, hoists, pumps and all other necessary apparatus of the highest grade in use for the work to be performed and having a capacity sufficient to meet not only unusual conditions but emergencies, and to afford a margin for repairs at all times. Provision must be made for storing in tanks at the boiler house enough

feed water for twelve hours' supply, unless connections can be made with two independent and separately sufficient sources of supply. If electricity is used for operating compressors supplying air to the tunnel headings, the supply cables shall be in separate lines and shall each connect, if possible, with two independent and separately sufficient sources of current.

The compressors shall be capable of furnishing simultaneously to each heading an air supply sufficient in volume and pressure to enable work to be done as nearly as possible in the dry, and to afford the specified degree of ventilation. At each heading where the shield is used the air supply pressure of 45 lb. per square inch above atmospheric pressure must equal at least 10,000 cu. ft. of free air per minute as measured by piston displacement, unless both tunnels are operated from the same compressor plant, when this air supply may be reduced to 8,000 cu. ft. of free air per minute. The plant, in addition, must be capable of furnishing to all parts of the work a sufficient air supply at a pressure of 100 lb. or more if required for operating drills, grouting machinery and other pneumatic tools. The air for the compressors shall be drawn from pure outside sources and protected from fouling by lubricating oil.

The compressor revolutions shall be registered by mechanical counters, and the pressure in the air receiver shall be continuously registered. Cooling apparatus shall be provided to maintain the temperature of the air in the tunnels and caissons always at a moderate degree. All buildings for the compressor plant and in the immediate vicinity shall be as nearly as practicable fireproof and all reasonable precautions shall be taken to prevent and extinguish fires. A water line shall be extended into each heading, 200 ft. of hose, and nozzle connections shall be maintained ready for constant use at each bulkhead and no lighted candles or matches will be allowed near roof timbering in compressed air.

MEDICAL AND SANITARY RULES

The workmen's quarters shall be well lighted, heated and adequately provided with running hot and cold water, showers, lockers and facilities for resting, for drying clothing, and for providing hot coffee. Care shall be taken to keep all parts of the tunnel in a thoroughly sanitary condition and free from refuse or decaying matter. There shall always be on duty a competent physician and surgeon experienced in the treatment of the physiological effects of compressed air, and he shall care for the health of the employees and supply treatment and medicines to them whenever needed.

There shall be maintained in close proximity to the shaft at each side of the river a completely equipped hospital room with an attendant constantly in charge. Each hospital room shall include in its equipment a commodious hospital lock in two compartments, where men can be subjected to the regular working pressure if attacked by caisson disease. Such locks shall contain cots, a telephone, air gage, and arrangements for ventilating and heating. Provisions shall be made for the immediate removal and hospital treatment of any employee who may be injured or become ill. No person shall be employed in compressed air until after passing a satisfactory medical examination, and any employee absent for ten or more successive days shall be re-examined before being permitted to resume work in compressed air.

All reasonable facilities shall be afforded for the investigation of the physiological effect of compressed air, including the conduct of experiments and the collection of records in connection therewith, to be undertaken by such scientific bodies of individuals as may be designated for the purpose by the commission.

AIR CHAMBERS

Air chambers shall be formed in the tunnels by brick, concrete or steel plate bulkheads of sufficient strength to safely resist a pressure of 15 lb. per square inch. Whenever the air pressure in the heading exceeds 22 lb. per square inch above atmospheric pressure, two air chambers shall always be in use, except when headings are being started from shafts, and the pressure in the outer one shall not exceed one-half the pressure in the heading. The distance from the heading to the nearest bulkhead shall not exceed 800 ft. during the progress of the work.

Three metal airlocks are to be firmly set and anchored in each bulkhead. These shall consist of two main locks not less than 6 ft. in diameter, heated and ventilated if required, and an emergency lock not less than 5 ft. in diameter, which shall be located as high up from the bulkhead as practicable and shall be large enough to hold an entire heading shift. When not occupied the emergency lock shall be kept open toward the heading and ready for instant use at all times. Lock doors must oper-

ate easily. A heavy glass bull's-eye must be set in each end of each lock.

Air valves must be arranged to be controlled from inside the lock. One of the main locks shall be connected to the main air line so that it may be locked from outside. Each lock shall be provided with an air gage and a clock. An 8½-in. air gage shall be placed in an accessible position on the outer side of each bulkhead. A recording air gage shall be placed on each main and shall be locked and the key kept by the engineer. A lock tender shall be on duty at all times at each lock bulkhead. A watchman shall be on duty at all times in the heading and when for any reason the work is suspended.

SAFETY SCREEN

In each heading chamber, when the same extends beyond the river bulkhead line, there shall be provided a safety screen extending from the springing line of the tube to the track. It shall be made of substantially braced steel plates with airtight joints. It shall be moved forward as the work progresses so as never to be more than 115 ft. in the rear of the shield. In each heading chamber, when the same extends beyond the bulkhead line, the contractor shall provide about the middle of the height of the tunnel a substantial runway, at least 3 ft. wide, leading from the shield platform to a platform at the emergency lock. The runway shall be provided with a handrail and steps or ladders at frequent intervals for access from the track level. A telephone connection shall be maintained in service from each heading and each lock to the power house and to the office of the commission's engineer corps near the shaft.

The air supply through the shaft and tunnel in each heading shall be through two pipes, each at least 10 in. in diameter, with sufficient capacity to prevent excessive drop in pressure in regular working. Each supply pipe shall be provided with a pressure-regulating valve in each air chamber and with suitable valves arranged for by-passing at a convenient point between the power house and the shaft. Special devices shall be used to deaden the noise of air supplied or exhausted.

The supply of fresh air shall be sufficient to permit work without danger or discomfort, and where work is in compressed air such supply shall be sufficient at all times and places to prevent the accumulation of carbon dioxide to a greater amount than one part in one thousand by volume. A foul-air vent pipe 6 in. in diameter shall be carried back from each heading under pressure to the ordinary atmosphere and shall be provided with a suitable regulating valve so placed as not to be readily tampered with. The compressors must be so run as to maintain at all times a change of air through the regulating valves. Special means must be provided for the rapid removal of blasting fumes.

THRILLING SUBMARINE EXPERIENCE

The following account of the unparalleled experiences of the Russian submarine Mingoa comes to us through a correspondent of the *Railway and Marine News*, Seattle:

Water leaked through a defective ventilator until the trim of the submarine was affected and she plunged head foremost to the bottom. Owing to a series of unfortunate delays the vessel was not brought to the surface until nine hours after her disappearance. When the after-hatch was opened three men staggered out, barely able to crawl. Fifteen of the crew and the captain were got out unconscious from the after-part of the vessel. There remained only the coxswain, who was in the conning tower amidships. It was necessary to raise the submarine well out of the water to get at the conning tower, and this took another three hours' work, but the coxswain, when released after twelve hours' confinement, was in the best condition of any of the crew. Water had continued to enter until the air in the vessel was so far compressed as to resist the entrance of any more. On this air the crew of twenty survived, the captain and fifteen men in the body of the vessel suffering also from the fumes of chlorin gas given off by the accumulators. The three men who crawled out unaided from the after-hatch, and the coxswain who, after being confined in the conning tower three hours longer than any of the mates, was yet the least affected, were apparently out of reach of the chlorin gas fumes. All have now recovered from the effects of their terrible experience.

The usefulness of the emergency buoy, which is also employed in the French submarine service, is amply demonstrated by the Mingoa accident. But the success of the rescue, after all, depended mainly on the "natural" factors of the case; the favorable weather

conditions, and, above all, the fact that the accident took place in comparatively shallow waters. Had the depth been twice or thrice the seven fathoms of the Mingoa—and submarines exercise at great depths—the balance between the pressure of the water and the compressibility of the air contained in the vessel would have been against the probability of the survival of any of the crew, while the enormously increased difficulties of salvage with increased depth would likewise have been all against the liklihood of saving life.

ELLIOTT CRESSON GOLD MEDAL AWARDS

The Franklin Institute has awarded its Elliott Cresson Gold Medal, the highest award in its gift, to the following:

Prof. Karl Paul Gottfried Linde, Ph. D., in recognition of his scientific investigations of the processes of refrigeration and the liquefaction of gases and of his inventions of machinery for applying these processes in the manufacture of ice and for the purposes of cold storage.

Prof. Edgar Fahs Smith, Ph. D., Sc. D., LL. D., in recognition of his leading work in the field of electro-chemistry, of his many contributions to the literature of chemical science, and of his great service in university education.

Joseph Maria Eder, Ph. D., in recognition of his important original researches in the science of photo-chemistry and of his many valuable contributions to the literature of that science and of the graphic arts.

Orville Wright, B. S., LL. D., in recognition of the epoch-making work accomplished by him, at first together with his brother Wilbur and latterly alone, in establishing on a practical basis the science and art of aviation.

KARL PAUL GOTTFRIED LINDE

The following is a brief sketch of the life of Professor Linde as given out by the Franklin Institute in connection with its award of the Cresson Gold Medal.

Karl Paul Gottfried Linde, Ph. D., was born in Berndorf, Oberfranken, on June 11, 1842. From 1866 to 1868 he was director of the construction department of Krauss & Co.'s Locomotive Works, Munich, Bavaria. In 1868 he was appointed assistant professor at the Technical High School, Munich, and three years later professor. From 1879 to 1890 he was manager of the Linde Ice Machine Company.

He was the pioneer in the manufacture of ice on a large scale, and in the introduction of liquid ammonia as the refrigerant in ice machines and cold storage systems. The refrigerating machinery mostly used at the present time, known as the ammonia "compression" system, is essentially Linde's invention. In applying the principle of self-intensive refrigeration, i. e., by utilizing the cold produced by allowing compressed air to expand, Prof. Linde was the first one to liquefy gases like air without the use of other liquefied gases and on a large scale. He also devised an ingenious process for the fractional liquefaction of air by which the bulk of the commercial oxygen is now manufactured. Thus the life work of this great engineer and inventor includes at least three achievements of the first magnitude:—The invention of the almost universally used liquid ammonia ice machine; the construction of the first and most successful liquid air machines and the devising of the process of making oxygen by its liquefaction from atmospheric air.

PNEUMATIC RIVETERS AND RIVETING CONDITIONS IN STRUCTURAL WORK

The field connections in the lower seven stories of the Equitable Building, New York City, are very largely made with 1⅛-in. rivets, of grip up to about 9 in. It has been found that to drive these rivets successfully the largest obtainable pneumatic hammers are required, and air pressures up to 110 lb. must be used. Further, it is important that the point of the rivet be no hotter than the shank under the head, and in some cases the rivets are cooled at the point by dipping into water.

In the early stages of the work, a rather heavy percentage of rivets was condemned by the inspector, in some cases because not enough stock had been left for the heading up. As these rivets are now being used a length of 2⅛in. is allowed over the grip to form the head and to supply metal for the upset. This allowance is somewhat excessive, but it gives a safe margin to allow for any overrun in the size of hole, etc.

Practically all the field-connection holes are reamed out after assemblying, in spite of the

fact that they are already drilled holes. The reaming insures a perfect match and guards against difficulty in entering the hot rivet.

The hammers used are long-stroke Boyer and Ingersoll-Rand $1^{13}/_{64}$x8-in. hammers.

The experience of the riveting gangs of the Thompson-Starrett Co. as stated by the boss of riveters, is that about 50% more ⅞-in. rivets, or about 75% more ¾-in. rivets could be driven in the time required for a given number of 1⅛-in. rivets. This, as will be seen, means that the 1⅛ in. rivets do not cost more per sq. in. to drive than rivets of smaller size.—*Engineering News.*

THE DIESEL ENGINE

The following concise statement of the essential features of the Diesel engine we take from a paper by J. T. Milton before the Institution of Naval Architects.

Diesel engines are broadly divided into two classes, namely, the two-stroke and the four-stroke. In both types a cylinderful of air at atmospheric pressure is compressed by the piston at the top center till its pressure becomes about 500 pounds per square inch. The compression raises its temperature to about 1,000 degrees F. At this instant a small quantity of oil fuel is blown into the very hot high-pressure air by means of a blast of air at still higher pressure. The oil is broken into a fine spray and its admission lasts only for one-tenth of the downward stroke. During this short time much of the oil is burned in the hot air. The aim is that the combustion shall proceed at the critical rate which shall permit the increase of volume occupied due to the motion of the piston and the increase of temperature to be so balanced that the pressure will remain constant until all of the oil has been burned. After this the expansion of the hot gas will still further push the piston down and the pressure will rapidly decrease. The maximum temperatures actually obtained in the cylinders are very high, approximating in some cases nearly 3,000 degrees F. It is these exceedingly high temperatures which occasion much of the special difficulties of Diesel engines, and it is necessary to keep the rubbing surface of the metal exposed to the hot gases sufficiently cool to permit of their retaining their lubrication; it is also necessary to prevent all the metal with which the heat comes in contact from becoming so overheated as to impair its strain-resisting properties.

ATMOSPHERICS

From the London Spectator

(Atmospherics, or "X's," are the sounds caused by atmospheric electricity. They are particularly strong at night, and they frequently interrupt wireless messages).

There's a little green devil that sits all the day
Up aloft with his feet on aerial wires:
He's booked for the day and has to obey,
But I guess he would like to get back to the fires—
Yes, I'm sure he would like to get back to his fires.
It's all right in the day with the sun shining strong,
But at night, to keep warm, he will dance on the wires,
And then—atmospherics start coming along!
The X's, the X's,
Oh, bother the X's!
For that's when the X's start coming along!

You've picked up a ship at the deuce of a range,
Or you're taking the news and can only just hear,
And the devil gets cramped and decides on a change—
Stands up, swings his arms, thinks of you with a jeer!
Shuffles down, prances up, heel and toe—(with a jeer)!
And begins his own dance to his own little song,
And there's not a word more of your message you'll hear—
For now atmospherics are coming along!
The X's, the X's,
Oh, bother the X's!
"Very strong atmospherics" are coming along.

He's fond of a hornpipe, and good at a jig,
A valse he calls "slow" and a minuet "old"—
For such stately dances he "don't care a fig,"
What he wants is something to keep off the cold.
But oh! when the night is especially cold,
It's tango, plus cake walk, plus popular song!
It'll turn your hair gray, it'll make you grow old
When X's in ragtime start coming along!
There's nothing that vexes
So much as the X's,
When X's in ragtime start coming along!

JOHN ENGLISH.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

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NECESSARY REQUIREMENTS FOR WORK UNDER PRESSURE

The specifications relating to the use of compressed air in the additional subway tunnels to be driven under the East River, as printed elsewhere in our present issue, mark a distinct advance in compressed air practice, certainly in so far as the safety of the workers is concerned. As pointed out by Frank Richards first in *Engineering News* last year, the laws defining the conditions under which men are to be allowed to work in air under pressure have been peculiarly deficient in their provisions, in that they have referred to pressures alone, and have had nothing to say about the condition of the air furnished, or the systematic renewal of it while work is in progress and especially during the process of decompression.

It is a strange thing that those who have professionally investigated the phenomena of caisson disease, who have experimented with the purpose of developing the best modes of treatment, and have presented more or less elaborate reports upon the subject, have had little to say about any air condition except the pressure. It would seem that some of the reports which are accepted as authoritative should be rewritten with the insertion of data covering the necessity of constant renewal of the air and its maintenance at a certain standard of purity while work is in progress and during all the stages of decompression. It is not to be wondered at that the compilers of laws relating to work in compressed air have not gone farther in their requirements than these investigators have led them.

In these trying days of summer we, who are not subjected to any abnormal air pressure, are uncomfortably and even painfully affected by slight increases of atmospheric humidity. How much greater must be the baleful effect of increased air pressure when to that are added humidity changes, decreases of oxygen content and accessions of various noxious gases.

It is well when these matters are taken in hand by the great contracting companies without legal pressure. The specifications prepared by Mr. Noble are essentially good business and at the same time they are such that the lawmakers may take lessons from them and so shape their enactments that all air workers may be assured safe working conditions. The

"sand hogs" are not always the best authority as to what is good for them, and are sometimes loath to accept and strictly comply with wise and proper regulations and it is well to have it all settled in a business way before beginning operations.

IMAGINARY "CAVES OF THE WINDS"

The *Saturday Evening Post,* we are assured, feels its responsibility and is usually careful as to the matters, little or big, which its puts before its millions of readers. Nevertheless it cannot be always correct, and the following, from a recent issue, is one of the instances wherein it is misleading. It says:

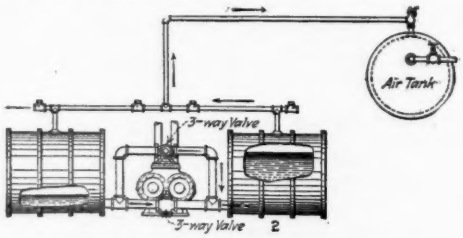
"At the great Anaconda Mines * * * an underground rock receiver was blasted out at the foot of a hill and compressed air is pumped into this receiver. Far up on the hill is a reservoir of water, with a pipe running down below the air receiver and coming up into it through the bottom. The water from the reservoir would naturally flow down into the air receiver, but the air pressure there keeps it out. When the stock of stored-up compressed air is reduced water comes up into the air receiver, and when an excessive amount of air is pumped in, the water in the hill reservoir rises; but the air pressure in the rock cavern always remains steady."

There is no such rock storage of compressed air at the Anaconda mines, but there is instead an imposing group of upright steel receivers connected together, a view of which has appeared in our pages. The constant air pressure is, however, maintained in the receivers by the head of water as described. We have repeatedly given accounts of the use of abandoned tunnels or other rock excavations for air receivers, but not at Anaconda Mines.

NEW BOOK

Safety and Efficiency in Mine Tunneling, by David W. Brunton and John A. Davis, Government Printing Office, Washington, D. C., 271 pages, 6 by 9 inches. Many illustrations.

This is to be regarded as one of the best—which is saying a great deal—of the many valuable publications of the Bureau of Mines. Why *mine* tunneling is specified in the title is not apparent, since water tunnels and railroad tunnels are perhaps more in evidence. Not only are the causes and modes of prevention of mine accidents fully discussed, but the entire field of tunnel construction is gone over with accounts of both the methods and the mechanical agencies employed. The book is conveniently practical and is based upon actual and reliable information. A great number of the most prominent tunnels were visited by the writers and all that has been written upon the subject seems to have been thoroughly gone over. A Bibliography relating to tunneling at the end of the book fills 27 pages.



AN EMERGENCY AIR COMPRESSOR

The sketch here reproduced from *Power* was contributed to that publication by Mr. F. W. Hudson, Ager, California; his rather meager description is as follows:

"We were in urgent need of a small air compressor. An idle steam pump and nearly all the fittings were at hand, so the pump was connected up as shown. Everyone was agreeably surprised at the results. Any air-tight receptacles, such as oil or plumbers' tanks may be used, but the greater the capacity of Nos. 1 and 2, the fewer the shifts of the three-way valves for a given quantity of air. The capacity of the compressor is equal to its displacement in gallons or cubic feet."

This arrangement might have done for an emergency, but is not to be thought of as an installation with any suggestion of permanence, and even in the emergency the water pump—with valves and pistons reasonably tight—would probably have pumped the air directly into the receiver quite as satisfactorily without all the paraphernalia here employed, the waste of power being great in either case. The manipulator of the three way valves probably would have also a lot of adjusting of the pump throttle, since the power required at the beginning of the filling of the tank with water, with no air pressure above it, would be very small as compared with that required when the tank was nearly full with the compressed air pressure on the water.

AIR PRESSURES IN PLAYING WIND INSTRUMENTS

In an interesting article in the *Philosophical Magazine,* Mr. Foord refers to Dr. Stone's table of wind pressures required to play various notes of the scale on various wind instruments. The table indicates that as the notes rise higher in the scale the air pressure necessary to produce them increases with most wind instruments, although not with all. In the clarinet, for example, the pressure decreases from the low notes to the high ones, varying from 15 inches of water to 8 inches. Mr. Foord repeated these experiments on the clarinet and saxaphone, playing the whole range of notes first loudly and then softly. For the clarinet it is found that the pressures fall as the notes rise, agreeing with Dr. Stone's table, although the inverse law holds good for the oboe, bassoon, horn, cornet, trumpet, euphonium, and bombardon.

With the saxophone it is found that the pressures corresponding to notes at the beginning and end of the register are equal, the pressure rising to a maximum at the note D about half-way through the scale.

TUG WITH AIR PROPELLER

What is styled by her builders an aerotug has been built by James Pollock Sons & Co., Ltd., London. This craft has a rectangular hull 30 by 10 feet, with square sides and bilges, and rounded up bow and stern. She draws about 8 inches of water and is designed for work in a river in Demerara, British Guiana, which has a maximum depth of only 13½ inches. The engine is a 15 horse-power single-cylinder Bolinder working on residual oil and coupled through a clutch to a spur wheel. A propeller revolving in the air instead of in the water accounts for her appellation. From the spur wheel a Hans Renold silent chain is laid vertically to a pinion on the aerial propeller shaft, which is geared up in the ratio of 450 to 1,200. The propeller shaft is carried in ball-bearings, which take both the pull of the chain and the thrust of the propeller, the bearings being mounted on a steel framework securely fixed and stayed to the framing of the tug. The propeller is 9 feet in diameter and the tug has a mean speed of 5 miles per hour, high speed being undesirable on account of the wash it would cause. The noise and vibration are considerable, but for the type of craft in which they are employed are of little importance. On the other hand, the boat seems to be a successful attempt to overcome the difficulty of navigation in shallow and weedy waters, and is capable of getting under way promptly. The propeller was designed and made by the Aero Propulsion Syndicate, Ltd., of Victoria street, Westminster.

DIFFERENT VIEWS OF MINING

Hazel, you see, her mineralogical lore being derived wholly from the movies, had never even heard of the sort of mine that was just a big, uncompromising mountain all seamed and fissured with streaks of green rock that had to be dug and blasted out of it—rock which, when ground and slimed and separated and roasted and smelted, produced copper and silver and lead and zinc and other uninteresting elements in varying proportions to the ton; of a mine that wanted money and patience and hard work, and then, insatiably, more money and more patience and more hard work, before it even began to yield up its treasure to you.

A mine, to Hazel, was a little pocket in the rock into which the thirst-parched and half-delirious prospector reached an emaciated arm and began pulling up irregular nuggets about the size of base balls, of pure twenty-four carat gold. The moment before you found it you were penniless—desperate. The moment after you found it you were rich beyond the dreams of a stage multimillionaire. One day you were perishing for a crust of bread—the next you were buying an automobile, a racing stable, and a palace on Fifth avenue.—*Saturday Evening Post.*

THE SECOND SIMPLON TUNNEL

The building of the second Simplon Tunnel has made such good progress, despite a serious strike and an attempt on the life of Chief Engineer Rothpletz, that the last stone in the high-pressure portion has already been laid. This portion of the tunnel, which is about 46 yards in length, is exactly co-terminous with and parallel to that which gave so much trouble in the first Simplon Tunnel. In 1901, when the borers of the first tunnel entered this part of the mountain, copious hot springs gushed

out, making work for the time being impossible, and seven months were required to push the bore through these 46 yards, and eighteen months to complete and line this short length. Only five months, however, have been required for the same work over this portion in the second tunnel. But before it was begun the engineers went all through the high-pressure zone in the first, and strengthened it throughout with strong iron scaffolding.

THE DRILL SHARPENER AT SOUTH AFRICAN MINES

Even the smaller economies when reflected over the enormous tonnage handled by the mines of the Rand, mean large aggregate savings, and one direction in which investigation appears to be called for with a view to the reduction of costs is in regard to the sharpening of drill bits. The greater part of this work on the Witwatersrand is now performed by machines, and the saving, through the employment of mechanical appliances, as against hand-sharpening, is very large. From a reliable authority we understand that economy to the extent of something like 39s. per 1,000 steels handled results from drill sharpening by mechanical appliances, as against sharpening by hand. We learn that to-day about 80 per cent. of the bits employed in Main Reef mines are sharpened by hand, and this naturally leads up to an inquiry as to why all mines do not adopt the obviously more economical method. In other words if eight-tenths of the Rand's technical talent is of the opinion that the sharpening of drill bits by machine is more economical than by hand what reasons can the adherents to the more antiquated method adduce for their conservatism?—*South African Mining Journal.*

NOTES

Sun-motors being tried experimentally in Egypt require 250 square feet of sunshine per brake horsepower developed.

A New York contractor always wears a derby in tunnel work, because it acts as a bumper and often saves his head a knock in dark and crowded quarters.

The paper used by the U. S. Government printing office each year requires approximately 62,500 tons of rag pulp and 245,000 tons of wood pulp.

The world's present total production of fuel oils of all kinds is slightly less than 55,000,000 tons, of which 47,250,000 are petroleum oils; this is about 5 per cent. of the world's present coal output.

The Canadian Northern Railway had its beginning in 1896. For seventeen years it has averaged a mile of new line a day, and this year it will boast a complete transcontinental line from the Atlantic to the Pacific.

"Mr. R. C. Cole has joined the staff of the Pneumatic Tool Dept. of the Ingersoll-Rand Co., and has been stationed at the Chicago office."

In the state of Puebla a track cable weighing 29,000 lb. was carried to a mountain top in connecting coils of about 100 lb. each, by an army of peons. When mules are employed about 220 lb. is allowed to each mule.

In the Challenge district, California, the uncovering of gold quartz by ants led to the discovery of a rich pocket of gold. Attention was attracted to the place by traces of gold near the ants' nest.

Flying with a wind that was blowing at 62½ miles an hour, an aeroplane carrying two German military airmen recently made a flight from Hanover to Berlin, 160 miles, in almost exactly an hour.

Trials have been made in Germany to ascertain the possibility of using the oxy-acetylene torch for removing the scale in boilers. These are reported to have been successful. The deposit is immediately removed without injury to the plate.

The driest place in the world is said to be in Egypt betwee the two lower falls of the Nile. Rain was never known to fall and the inhabitants do not believe travelers who say that water can fall from the sky.

A cofferdam employed in building a bridge pier at South Norwalk, Conn., which collapsed with fatal results May 20 was spoken

of in the daily papers as a pneumatic caisson. This was a mistake, as no compressed air was used.

The lowest point of dry land in the United States is less than 80 miles from the highest. The lowest point is in Death Valley and is 276 ft. below sea-level. It is said that from this point Mount Whitney, 14,501 ft. above sea-level, can be easily seen on a clear day.

It has been shown by the Bureau of Mines that electrical energy can be developed more cheaply in the Lousiana gas field by using the gas in-gas engines, directly connected to electrical generators, than in the waterpower plants of Niagara.

Soon the farms will depend on the engineer, not only for the machines to work the soil and harvest the crops, but for the raw material, fertilizer, which combined, through the soil, with the germinating seed, produces the plant which is the basis of all food, either animal or vegetable.

An international tunnel said to be the only tunnel in North America to cross an international boundary line, is about to be started on the San Diego & Arizona Railway. Although the bore will be only 620 ft. long, one end will be in the United States and the other in Mexico.

The Caspian Sea which forms part of the boundary between Europe and Asia, 730 miles long and 150 to 270 miles wide, is slowly but surely shrinking. Although it is 80 ft. below sea level and can have no outlet, the rivers flowing into it, the Volga, the Ural, the Terch and the Kur are not a match for the winds that blow over it. The sea abounds in fish, also seals and tortoises and there is an extensive local commerce, none of which, apparently, can last forever.

A new potato grown in France, *Solanum Commersoni*, contains a violet coloring matter which proves serviceable to chemists. If the potatoes are boiled in water the ferments are destroyed and the resultant colored solution keeps well. As an indicator it is very sensitive, turning green with alkalies and bright red with acids.

Joseph Hall has just retired after 57 years of service as an engineman for the Maryport & Carlisle Railway of England. He must have been fortunate as well as faithful, since he had never had a single mishap and had never had a demerit mark against him.

A miner carrying a glass jar filled with calcium carbide had arrived at his work in the mine when he let the jar slip and it was broken into many pieces on a rail. The carbide rolled into a ditch at the side of the track, where there was running water. The water generated acetylene gas, the light on the miner's head ignited it, then came an explosion, and he was badly burned.

The city of Buenos Aires, Argentine Republic, recently opened the first two-mile section of a subway system which, when completed, will extend eight miles and connect all parts of the city. The running time between the two important plazas connected by the subway has been cut in two. A unique feature is distinguishing stations by finishing each one in different colored tiles, one sky blue, one yellow, one green, etc., there being a station about every three blocks. Transfer tickets between surface lines and subway cost 2 cents.

Here are some of the characteristics of the 14-inch gun, carried by the New York and Texas. It is 45 calibres in length, that is 52 feet 6 inches. It weighs 63.4 tons, has a muzzle velocity of 2,600 feet per second, and fires a shell weighing 1,400 pounds. At a distance of 10,000 yards its shell will penetrate over sixteen inches of the hardest Krupp armor. The Nevada and Oklahoma will carry ten 14-inch guns in four turrets. The Pennsylvania and Battleship 39 will carry twelve 14-inch guns in four turrets.

An experimental test has been made in Paris of a portable road-mending machine, consisting of a six horse-power gasoline engine, actuating an air compressor, the air being led from a storage tank to a pneumatic rammer and a pneumatic pick, the latter being described as merely a modification of the well-known pneumatic riveter. The workman holds the tool close to the road and pushes the pick under the surface, raising it up as he proceeds. It is said that the work was done at a much

faster rate than was possible with the ordinary pick. The pneumatic rammer also gave good results. One advantage of the system is that several men can work from the same compressor plant.

Over $14,000,000 worth of rapid transit contracts were let recently in New York, one of them being the largest single contract since the $35,000,000 contract awarded to John B. McDonald for the construction of the present subway. The contract now spoken of was for the construction of the two tunnels under the East River from downtown Manhattan to Brooklyn. Booth & Flynn, Ltd., and the O'Rourke Engineering Construction Co., on their joint bid of $12,444,726, secured the work. One of the tunnels will run from Whitehall St., Manhattan, to Montague St., Brooklyn, and will be operated by the New York Municipal Railway Corporation; the other will run from Old Slip, Manhattan, to Clark St., Brooklyn, and will be operated by the Interborough Rapid Transit Co.

The Roumanian government has awarded to Julius Berger Tiefbau Aktiengesellschaft the contract for building the Isvor Tunnel on the Sinaya-Moreni line. The tunnel is about 4 miles in length and the cost about $2,500,000, though the price is not fixed, but is calculated at fixed partial rates according to the material encountered. The time for construction is 28 months, and the work is to be begun at once. Part of the plant which the company is using for the Swiss Hauenstein Tunnel will be transferred to the Isvor Tunnel. The Hauenstein Tunnel, which is situated on the Basel-Sissach-Olten line, is 26,700 feet long, and satisfactory progress is being made, 14,500 feet having been pierced on the south side and 6,700 feet on the north side. The contract requires the lower headings to meet by January 13, 1916, and the line to be ready a year later, and the works are well ahead of time.

Manufacturers of the Naugatuck Valley, Connecticut, are making preparations to carry out a plan, which has been under contemplation for some years, to create a great reservoir to store the flood waters of the basin for use in dry seasons, to create power at dams lower down the stream, and especially to flush the river bed, that any nuisance that may exist will be eliminated. The engineers' plans call for a reservoir that will contain 15 billion gal., a capacity which has few equals in the East. The location is in Thomaston, where the dam will confine the waters of three important feeders of the Naugatuck River.

Snow disappears at high altitudes without melting. The matter is not a mysterious one for the snow actually does disappear as water vapor into the atmosphere, without melting. A reference to the equilibrium curve between solid, liquid, and gaseous water, which appears in nearly every recent textbook on physical chemistry, will show that the change from the solid to the gaseous state is the normal one at low pressures and temperatures.

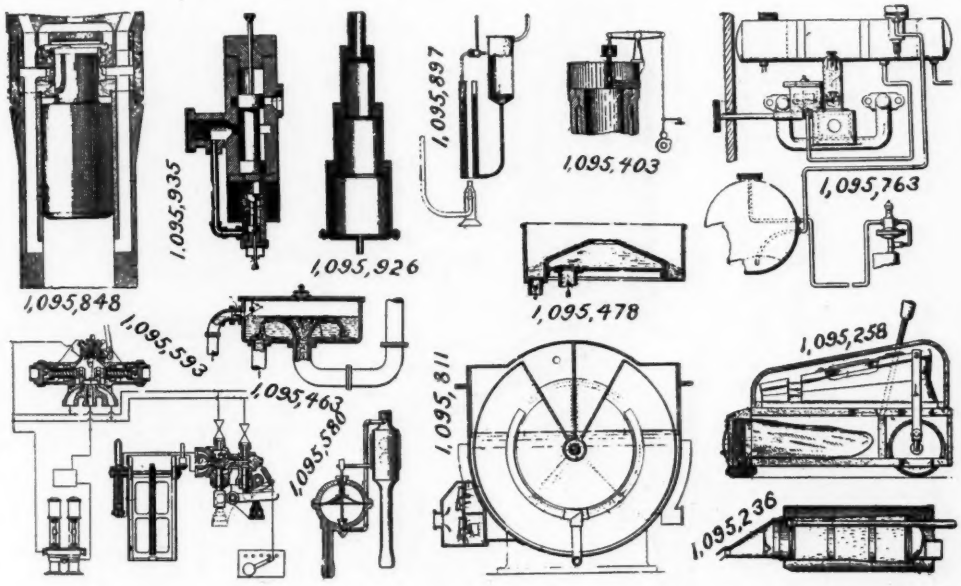
The governments of Sweden and Denmark have had plans made for the construction of a tunnel under the sea channel that separates the two countries to accommodate a railway that will establish direct communication between Stockholm and Copenhagen. The submarine tunnel will be about nine miles. Some thirty miles of railway will have to be built in connection with the tunnel. It is estimated that railway and tunnel will cost about $25,000,000.

A novel method of preventing local fogs is at present being tested by experiment. During the winter months Lyons is frequently covered with dense fogs, caused by evaporation from the neighboring rivers. The Director of the Lyons Observatory has shown, from the contour of the land and the movement of fog banks, that if evaporation from the Saone could be checked for a stretch of about a mile and a half above Lyons, fogs over the town would be prevented. To effect this, 72 litres of oil are being spread over the surface each day. This small amount gives an oil film thick enough to stop the evaporation.

The Khojak tunnel in Beluchistan, with a length of two miles and 769 yd., is the longest railway tunnel in Asia. It is on the Chaman extension of the Sind-Pishin section of the North Western Railway of India. This extension was built between the years 1888 and 1891 in consequence of the fear of Russian aggression. The tunnel pierces an historic pass across the Khwaja Arman offshoot of

the Koba-Kakar Mountains. Two lines, of the Indian 5 ft. 6 in. gage, are laid through the tunnel which is, like most of the tunnels on the northwest frontier of India, guarded at each end by strong iron gates.

It would appear that our railroads are not so bad after all. According to reports compiled by the Bureau of Railway News and Statistics, 299 railways of the United States, operating a mileage equal to the combined railways of the United Kingdom, Germany, France, Austria and Italy, went through the fiscal year ended June 30, 1913, without a single fatality to a passenger in a train accident. The railways, which operate together 120,901 miles of line, constitute more than two-thirds of the operating companies making their annual reports to the bureau. During the year these railways carried a total of 409,808,488 passengers an aggregate distance of 14,400,992,000 miles, and 968,764,956 tons of freight a total of 141,790,227,000 ton miles. Almost one-half the entire railway traffic of the United States for the year thus was carried without one passenger being killed in an accident to a train.



PNEUMATIC PATENTS MAY 5.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MAY 5.

1,095,236. PUMP FOR VACUUM-CLEANERS. JULIUS SCHIRRA, Pittsburgh, Pa.

1,095,258. VACUUM CLEANING APPARATUS FOR CARPETS AND THE LIKE. MORRIS S. WRIGHT, Worcester, Mass.

1,095,403. COMPRESSED-AIR STARTING DEVICE FOR MOTORS. OLAV ESKIL JORGENSEN, Copenhagen, Denmark.

1,095,463. APPARATUS FOR REMOVING AIR FROM WATER. WALTER KIESER, Berlin, Germany.

1,095,478. MEANS FOR SEPARATING GASES FROM LIQUIDS. FRITZ STROHBACH, Charlottenburg, Germany.

1,095,498. DRYING JAPANNED OR VARNISHED LEATHER. ALFRED GENTHE, Worms, Germany.

The process of drying japanned or varnished leather which consists in drying air and passing it through a chamber, and exposing the said leather to light rich in ultra-violet rays in said chamber, the air being maintained substantially free from moisture.

1,095,580. OXYACETYLENE AND SIMILAR BURNER. FRIEDRICH KRAUSS, Munich, Germany.

1,095,593. FLUID-PRESSURE SYSTEM FOR OPERATING BULKHEAD-DOORS. FREDERIC JOHN PIKE, Beckenham, and HERBERT NEVILLE, Forest Hill, England.

1,095,763. FUEL-SUPPLY SYSTEM FOR AUTOMOBILES. ALEXANDER WINTON, Cleveland, Ohio.

1,095,848. FLUID-PRESSURE-ACTUATED TOOL. GEORGE H. GILMAN, Claremont, N. H.

1,095,871. DEVICE FOR OBTAINING A CONSTANT MIXTURE OF TWO ELASTIC FLUIDS. ALEXANDER CONSTANTINE IONIDES, Jr., London, England.

1,095,897. PROCESS FOR PRODUCING COMPRESSED AIR OR COMPRESSED GAS ESPECIALLY FOR THE OPERATING OF LAMPS. WILLIBALD LIEDKE, Berlin, Germany.

1,095,926. FLUID-PRESSURE CYLINDER AND PISTON. JOHN E. POWELL, Augusta, Ga.

1,095,935. ELECTRICALLY - CONTROLLED AIR-RELEASING VALVE FOR TRAIN-PIPES AND THE LIKE. THOMAS H. SHELDON, Victor, Colo.

MAY 12.

1,096,031. MINING-MACHINE. ARTHUR HENRY GIBSON, Easton, Pa.

1,096,092. VIBRATOR. ELMER LOUIS BISSON, Berwyn, Ill.

1,096,228. GAS-MEASURING INSTRUMENT. JOSEPH P. DELANEY, Pittsburgh, Pa.

1,096,275. PNEUMATIC TYPE-WRITER. MAX SOBLIK, Dresden-Klotzsche, Germany.

1,096,305. PNEUMATIC POTENTIAL-PRODUCING MEANS. JOHN A. JOHNSON and CARL M. HEDMAN, Chicago, Ill.

1,096,334. AIR-BRAKE-SETTING DEVICE. JOHN H. WATTERS, Augusta, Ga.

charge, and valve means for controlling the entrance of compressed air to the air inlet pipes, said valve means being controlled by air conveyed from the cylinders through the governor pipes to said valve means, valve means at an intermediate point of the air inlet pipes for admitting compressed air from said pipes to said discharge conduit.

1,096,607. DIVER'S SUIT. JEAN F. DERAY, Sunnyvale, Cal.

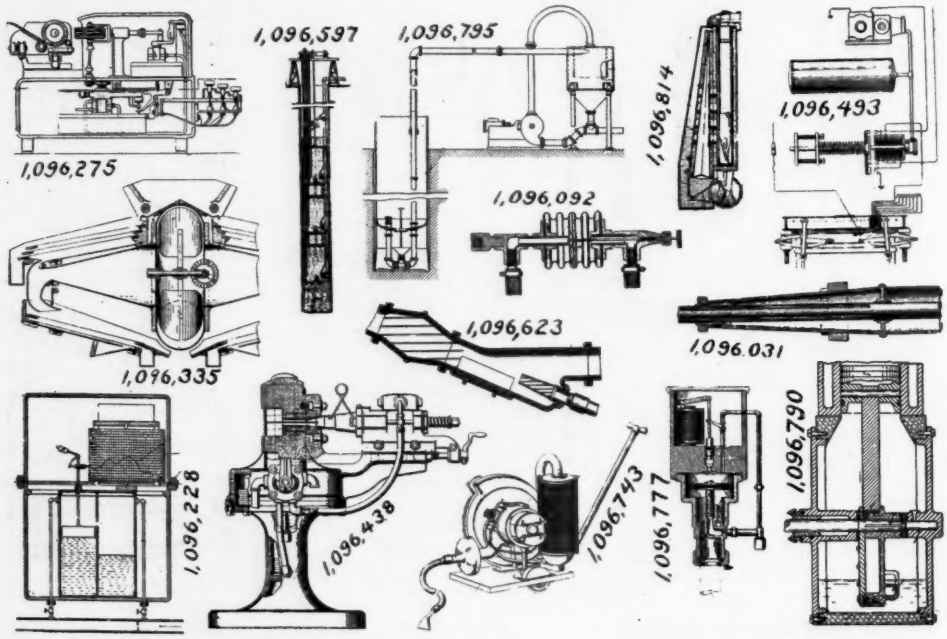
1,096,623. ASH-CONVEYER, ALEXANDER GIRTANNER, St. Louis, Mo.

1,096,743. PNEUMATIC RENOVATING-MACHINE. AMON T. NOE, New York, N. Y.

1,096,777. AIR - BRAKE - CONTROL - VALVE MECHANISM. ANDREW J. ALLARD, Richmond, Va.

1,096,788. FLUSHING APPARATUS. PATRICK J. MADDEN, Chicago, Ill.

1. In a flushing apparatus, the combination of a main tank, means for discharging liquid thereinto, a priming tank having an opening communicating with the main tank, a float valve for controlling said opening, the under side of the valve being immediately exposed to the fluid



PNEUMATIC PATENTS MAY 12.

1,096,335. DOUBLE SUCTION GRAIN CLEANER AND GRADER. WARREN WATTS, Hayes Township, Clay county, Kans.

1,096,408. DETECTOR AND ALARM FOR PNEUMATIC TIPES. SEYMOUR W. WATERHOUSE, San Jose, Cal.

1,096,437-8. FLUID-ACTUATED DRILL-BIT FORMING, SHARPENING, AND SHANKING MACHINE. JOHN GEORGE LEYNER, Denver, Colo.

1,096,493. LOAD-REGULATED GOVERNING DEVICE FOR FLUID-PRESSURE. JAMES S. DOYLE, Mount Vernon, and FRANK HEDLEY, Yonkers, N. Y.

1,096,597. PUMPING SYSTEM. WILLIAM A. BRUTON, San Dimas, Cal.

1. A pumping system comprising a plurality of submerged cylinders, a governor pipe and an inlet pipe extending into each of the cylinders, a discharge conduit, communicating with each of the cylinders and extending to the point of discharge, and valve means for controlling the entrance of compressed air to the air inlet pipes, said valve means being controlled by air conveyed from the cylinders through the governor pipes to said valve means, valve means at an intermediate point of the air inlet pipes for admitting compressed air from said pipes to said discharge conduit.

1,096,607. DIVER'S SUIT. JEAN F. DERAY, Sunnyvale, Cal.

1,096,623. ASH-CONVEYER, ALEXANDER GIRTANNER, St. Louis, Mo.

1,096,743. PNEUMATIC RENOVATING-MACHINE. AMON T. NOE, New York, N. Y.

1,096,777. AIR - BRAKE - CONTROL - VALVE MECHANISM. ANDREW J. ALLARD, Richmond, Va.

1,096,788. FLUSHING APPARATUS. PATRICK J. MADDEN, Chicago, Ill.

1. In a flushing apparatus, the combination of a main tank, means for discharging liquid thereinto, a priming tank having an opening communicating with the main tank, a float valve for controlling said opening, the under side of the valve being immediately exposed to the fluid pressure within the main tank, means for trapping a body of air immediately against said exposed under side of the valve, whereby as the liquid rises in the main tank it will compress the air and produce a sufficient fluid pressure upward immediately against the valve to unseat it, a siphon for discharging the liquid contents of the tank, and means for discharging into the priming tank a sufficient quantity of liquid to prime the siphon when the valve is unseated as aforesaid.

1,096,790. GAS - COMPRESSOR - DRIVING MECHANISM. CASPER W. MILES, Anderson township, Hamilton county, Ohio.

1,096,795. METHOD OF AND APPARATUS FOR SINKING SHAFTS. EDWARD O'TOOLE, Gary, W. Va.

1. The method of sinking shafts consisting in excavating within a caisson in forming the shaft depositing the excavated materials within a conduit leading from the caisson to the exterior

thereof, creating an outwardly flowing current of fluid pressure in said conduit to thereby carry water collecting in the caisson and the deposition of excavated materials there through and out of the caisson, separating and discharging the air independently of the removed solids carried through and discharged from said conduit, and causing the caisson to descend within the shaft as the excavation is deepened.

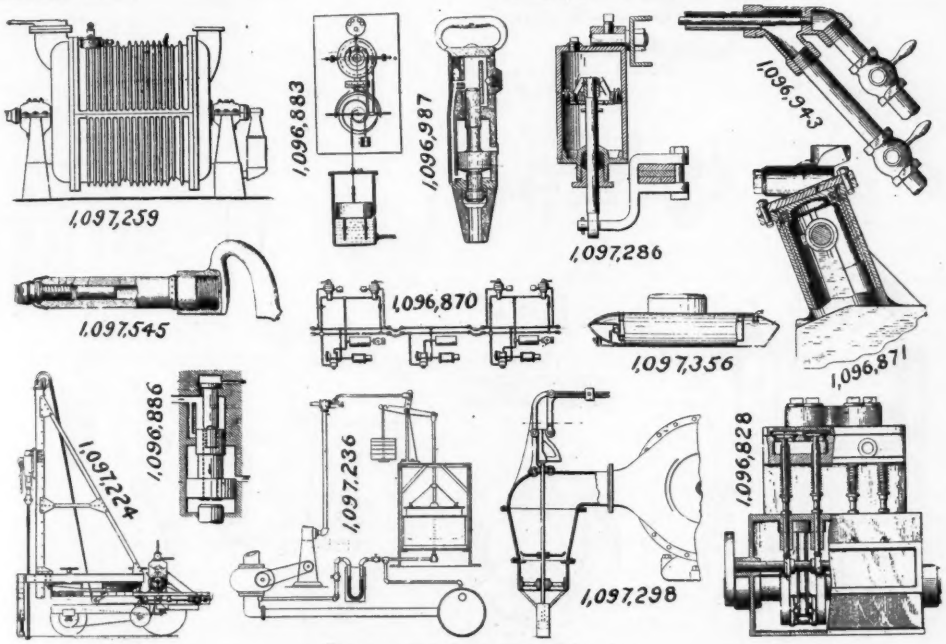
1,096,814. HAND-POWER VACUUM-SWEEPER. NELSON M. DYER and WILLIAM S. HOLBROOK, Davenport, Iowa, Filed July 12, 1913.

MAY 19.

1,096,828. VALVE MECHANISM FOR AIR COMPRESSORS. HUGH V. CONRAD, Pittsburgh, Pa.

1. The combination with a fluid compressor cylinder, of two inlet valves for controlling the admission of fluid to one end of the compressor cylinder and means for actuating said valves at different times.

1. In a water system, the combination of two gravity filled submerged reservoirs, two check valved conduits, one to each reservoir, led therefrom, a compressed air supply conduit, two air conveying conduits, one to each reservoir, a valve casing interposed between the air supply conduit and the two air conveying conduits, a valve mounted in said casing for alternately connecting the two air conveying conduits to the air supply conduit, a double lever connected to the valve, pneumatically controlled means operably connected to the respective ends of the said lever two conduits leading to the pneumatically operated means from the two air conveying conduits, a valve in each of said conduits, two floats, one mounted in each reservoir, two switches one controlled by each float, two electromotors for operating the valves of the pneumatically operated means, and two circuits including each a source of electrical energy, one switch of the reservoir, and one electromotor, whereby the valves are operated to alternately connect the two air conveying pipes to the air supply pipe.



PNEUMATIC PATENTS MAY 19.

1,096,832. APPARATUS FOR THE CONTINUOUS EXAMINATION OF LIQUIDS. OTTO FRIESE, Berlin, and FERDINAND GRAAFEN, Erfurt, Germany.

1,096,870. FLUID-PRESSURE BRAKE. WALTER V. TURNER, Edgewood, Pa

1,096,871. FLUID-COMPRESSOR. WALTER V. TURNER, Edgewood, Pa.

1,096,877. AUTOMATIC STOKER. HARRY L. WILLIAMS, Chicago, Ill.

1,096,883. FLUID-FLOW METER. HARLEY C. ALGER, Chicago Heights, Ill.

1,096,886. FLUID-OPERATED PERCUSSIVE TOOL. LEWIS C. BAYLES, Easton, Pa.

1,096,943. BLOWPIPE. CARL H. PEAKE, Detroit, Mich.

1,096,959. PNEUMATIC SPRING-WHEEL. ALBERT O. SCHOELCH, Shelbyville, Ind.

1,096,987. FLUID-OPERATED PERCUSSIVE TOOL. LEWIS C. BAYLES, Easton, Pa.

1,097,055-61. TRIPLE VALVE. JACOB RUSH SNYDER, Pittsburgh, Pa.

1,097,143. PNEUMATIC WATER SYSTEM. WILLIAM HENRY SINGLETON, Macon, Ga.

1,097,224-5. ROCK-DRILLING MACHINE. CHARLES C. HANSEN, Easton, Pa.

1,097,236. GAS - PRESSURE - REGULATING DEVICE. JESSE J. KERR, Cleveland, Ohio.

1,097,259. PREVENTING PULSATIONS IN CENTRIFUGAL COMPRESSORS. MELACH I. NUSIM, Lynn, Mass.

1,097,263-4. BLOWPIPE. WILLIAM I. REICH, New York, N. Y.

1,097,286. SHOCK-ABSORBER. JOHN BAKER, Jr., Los Angeles, Cal.

1,097,297. CENTRIFUGAL COMPRESSOR. JOHN G. CALLAN, Boston, Mass.

1,097,298. MEANS FOR PREVENTING SURGING IN CENTRIFUGAL COMPRESSORS. JOHN G. CALLAN, Boston, Mass.

1,097,356. AIR-SUPPLY APPARATUS FOR SUBMARINE VESSELS. PAUL PARNITZKY, New York, N. Y.

1,097,545. ATTACHMENT FOR PNEUMATIC RIVETERS AND SIMILAR TOOLS. HARRY B. GRINER, Philadelphia, Pa.

1,097,559. CONTROLLING MECHANISM FOR PNEUMATIC-DESPATCH-TUBE APPARATUS. ALBERT W. PEARSALL, Lowell, Mass.

MAY 26.

1,097,706. PNEUMATIC SELF-PLAYING MUSICAL INSTRUMENT. LEWIS B. DOMAN, Elbridge, N. Y.

1,097,729. CENTRIFUGAL AIR-COMPRESSOR. RICHARD H. RICE, Lynn, Mass.

1,097,756. ROTARY FLUID-PRESSURE MOTOR. THEODORE M. HIESTER, Dayton, Ohio.

1,097,783-4. PROCESS OF BLOWING ACID GASES. ROBERT B. WOLF, Berlin, N. H.

1. The process of blowing gases containing corrosive constituents, which consists in drawing the gases into the blower and introducing a neutralizing agent into the gas as it enters the blower for the purpose of depositing an inactive coating on the blower and finally delivering the gas therefrom.

1,097,804. PNEUMATIC EGG-CRATE. DAVID A. JONES, Wayne, Nebr.

The combination with a box having a hinged lid, of a pneumatic cushion secured within the box and lid, said cushion comprising a lid carried air chamber, a box carried air chamber, and a plurality of tranverse longitudinal air cells disposed on and connected with the box carried chamber, the box carried chamber, the lid carried chamber and the said transverse and longitudinal cells all communicating with each other, and an inflating valve carried by the cushion member whereby all of the cells and chambers can be simultaneously inflated.

1,097,865. ANTISIPHON-TRAP. JOHN CHARLES LAUTH, Rochester, N. Y.

1,097,878. AIR-COMPRESSOR. PATRICK H. REARDON, San Francisco, Cal.

1,097,879. PRESSURE-REGULATOR. JAMES H. REICHARD, New Orleans, La.

1,097,997. ROTATION DEVICE FOR FLUID-PRESSURE-OPERATED-HAMMER TOOLS. ALBERT H. TAYLOR, Easton, Pa.

1,098,046-7. STARTER FOR INTERNAL-COMBUSTION ENGINES. DON D. MILES, JR., San Francisco, Cal.

1,098,119. BURNER FOR AUTOGENOUS WELDING AND CUTTING OF METAL. MARINUS KONGSBAK, Lubeck, Germany.

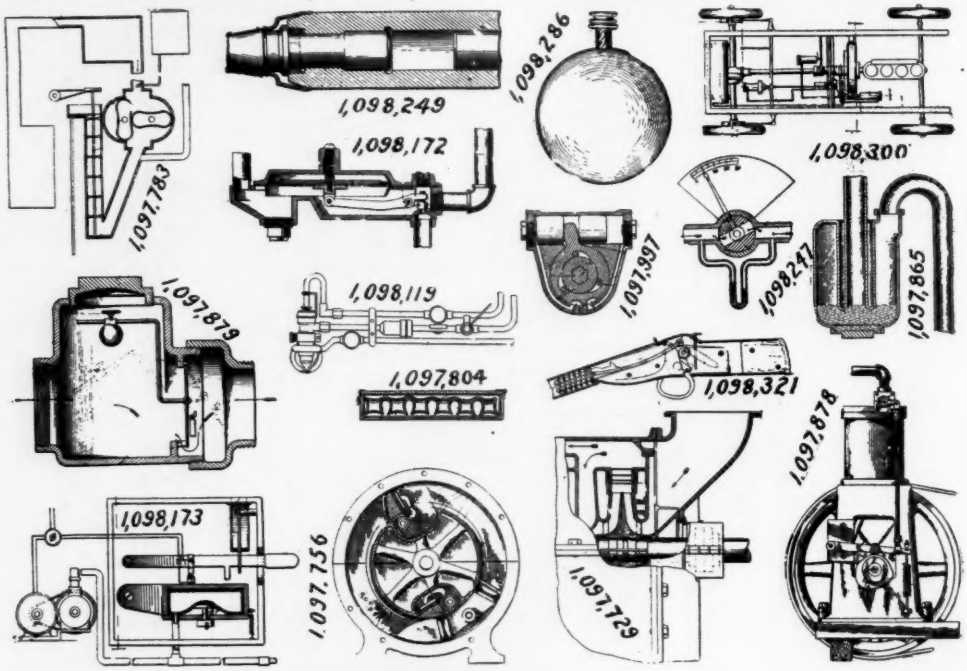
1. A device for autogenous welding and cutting of metal beneath the surface of water comprising a compressed air supply pipe, a ring on the inner end of said supply pipe and provided with apertures on one face thereof, a fuel supply pipe, and a burner on the inner end of said fuel pipe extending through said ring as described.

1,098,151. AIR-GUN. WILLIAM A. HEILPRIN, Philadelphia, Pa.

1,098,172. FLUID-PRESSURE REGULATOR. MIRON G. REYNOLDS, Anderson, Ind.

1,098,173. TIRE-INFLATING APPARATUS. FREDERICK A. RUFF, Newark, N. J.

1,098,247. APPARATUS FOR INDICATING OR MEASURING THE RATE OF FLOW OF FLUID THROUGH PIPES, OR FOR DETECTING LEAKAGE. GEORGE JAMES GIBBS, Preston, England.



PNEUMATIC PATENTS MAY 26.

1,098,249. ATTACHMENT FOR PNEUMATIC RIVETERS. HARRY B. GRINER, Philadelphia, Pa.

1. In a pneumatic impact tool, a barrel having the lower portion of its bore of stepwise decreasing diameters, an impact-plug of corresponding stepwise decreasing diameters and fitting in said bore, and means surrounding a portion of said plug and adapted to contact with said barrel for preventing upward displacement of such plug.

1,098,286. CLOSURE FOR INFLATABLE BODIES. THOMAS W. MILLER, Ashland, Ohio.

1. The combination with an inflatable body, of means for automatically retaining a portion of the same in a twisted condition to prevent passage of the inflating medium therethrough.

1,098,300. PNEUMATIC POWER-TRANSMITTER. FRANK M. PRATHER, Los Angeles, Cal.

1,098,306. VENTILATING AND OTHER FAN. HENRY JULIUS TRAUTMANN and JAMES LLOYD COPPING, London, England.

1,098,321. AIR-GUN. WILLIAM A. HEILPRIN, Philadelphia, Pa.